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THE BRIDGE RIVER DOGS: INTERPRETING ADNA AND STABLE ISOTOPE ANALYSIS COLLECTED FROM DOG REMAINS

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ADNA AND STABLE ISOTOPE ANALYSIS COLLECTED FROM DOG REMAINS

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Excavations at the Bridge River site have been on-going since 2003, increasing our understanding of the communities that inhabited the Middle Fraser Canyon, British Columbia over 1,000 years ago. The most recent excavation at Housepit 54 in the summer of 2014 supplied further data regarding relationships between people and their dogs. Dogs are well documented in the Middle Fraser Canyon through both archaeological excavations and traditional knowledge. A household's possession of a dog has been linked to other prestigious materials, and therefore been interpreted as an indicator of wealth and status. The present study was aimed at further investigation of the dog remains and the lives of the individuals that kept them. Ancient DNA analysis was conducted on a variety of dog remains from different occupations from Housepits 11, 16, 20, 24, and 54. Comprehensive stable isotope analysis of the same samples, with the addition of corresponding faunal remains for dietary comparison, was also completed. Results suggest a distinct mitochondrial lineage of dogs at Bridge River, and provide evidence for dietary change reflecting the complex relationship between the environment at Bridge River and the people that lived there.

Acknowledgements

I would like to thank the Stl'átl'imx Nation and the wonderful members of the Bridge River (Xwisten) Band for their hospitality during my time at Bridge River and the opportunity to investigate the prehistoric lives of early North Americans. I also want to thank Anna Marie Prentiss for providing me with the educational and professional experiences offered through her continuous work at Bridge River. A special thank you to both her and Meradeth Snow for their unwavering encouragement and support through the development and completion of this project. I would also like to thank Michael Farrell for encouraging me to purse an archaeological application for my forensic focus. Thank you to Matthew Walsh and Sarah Nowell for all their friendship and archaeological education during my time in the Bridge River lab.

Thank you to my parents, Susan and Walter Tifental; their love of science, anthropology, and the outdoors has played a tremendous role in my academic passions. My sister Amanda, for always talking me down from an analytical cliff, and my friends for their encouragement, forced breaks, and always giving me the perfect answer to "I'm think of a word that like …"

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Chapter 1: Introduction and Overview

The purpose of this study is the interpretation of ancient DNA (aDNA) and stable isotope analysis of domesticated dog remains from the Bridge River site EeRl4 in British Colombia in order to better understand the lives of their owners. aDNA analysis was done on 20 faunal remains identified as dog through morphological comparison. Thirteen of the samples were recovered from various occupation floors in Housepit 54, the remaining seven samples were recovered from four other Housepits, 11, 16, 20, and 24. Stable isotope analysis was conducted on the same 20 dog samples as well as five other faunal species for dietary comparison. Results from this analysis provide insight on three research questions:

1. Where do the mitochondrial DNA (mtDNA) haplotypes of Bridge River dogs fit into the phylogeny created from dog DNA in British Colombia, and can patterns of migration be interpreted from the results?

2. Can social inequality be determined through distinctive changes in the diets of dogs between different households during the same occupation period?

3. How does dog diet change through various occupations of a single household and how is it correlated to changes in the faunal assemblage?

In this analysis samples were chosen to address these questions.

Hypotheses

An aDNA and stable isotope study of this size has never been conducted at the Bridge River site. This research can potentially provide physical evidence for changes in settlement patterns, diets, and subsistence of the people of Bridge River. In collaboration

with the archaeological evidence from the extensive excavations that have been done and the outstanding body of academic literature produced, these data can aid in interpretations of how the people's lives changed in response to the dynamic ecosystem they inhabited.

The first research question is concerned with the identification of the Bridge River dog mtDNA haplotypes and their phylogentic relationship to others collected in the region. Its hypothesized the aDNA results will be consistent with past results; amplification of mtDNA is expected and likely to indicate one of the two haplotypes found in previous studies, suggesting two lineages of hunting or village dogs (Yang et al. 2010). It is also hypothesized that the results from three small vertebras collected from a pit feature during the earlier occupation, floor IIh (Appendix A) will show a third new haplotype, potentially identifying the Salish Hair dogs that have only been documented in ethnographies to date.

The second research question strives to identify evidence of social inequality through the comparison of two homes occupied at the same time but from varying regions of the village. It is hypothesized that through the use of the 'canine surrogacy approach' (CSA), the dog stable isotopic data can be interpreted as a reflection of their owner's diet (Guiry 2012). Ratios of carbon and nitrogen levels can be used to generally identify the ratio of terrestrial verse marine food sources in individual diets (Brown and Brown 2011). In this way, variation in stable isotopic results between houses has the potential to show signs of social inequality through access to prestigious foods. It is hypothesized some variation will be seen between samples from housepits in the south village, which showed less material wealth, than those housepits in the north village

which showed more material wealth, during the Bridge River 3 period (BR 3) between ca. 1,300 to 1,000 cal. B.P.

Stable isotopic data could also reveal changes in diet throughout the many occupations of a single house. This can potentially be seen from the samples of preserved *Canis* bones that were recovered from nearly every floor of HP 54; changes could reveal times of famine or variations in subsistence patterns.

The final research question investigates the faunal record and the stable isotopic analysis of dog remains; how the two correlate and change throughout the many occupations in a single household, HP 54. It is hypothesized that some change in subsistence will be detected as the village undergoes ecological and demographic changes near the end of both the BR 2 and BR 3 periods. The data are hypothesized to be complementary with recent analysis of the home's faunal assemblage (Walsh 2015). The results of these analyses will provide substantial evidence into the lives of the Bridge River people as well as potentially how they came to the region.

The interpretation of human behavior and subsistence patterns from the domesticated dogs they kept enables physical anthropologists to draw conclusions about populations when access to human remains is restricted. This study is intended to explore new avenues of research on the use canine remains as surrogates to aid in the interpretation of human activities. Drawing upon physical and forensic anthropological methods and non-human subjects, the goal of this study to develop a clearer understanding of the relationship between dogs and their human counterparts.

To best explore the relationship between humans and dogs at Bridge River, it is first prudent to review prior research done in the region. Chapter two starts with a section

on the environmental history of British Colombia and the Fraser River Canyon. As ecosystems change, so must the human strategies for survival. The second section reviews the settlement of the Canadian Plateau as interpreted from archaeological research. The final section considers archaeological excavations at the Bridge River site specifically. Chapter three reviews dogs, starting with the Salish hair dogs of the Northwest Coast, then both ethnographic and archaeological evidence of dogs on the Canadian Plateau, and lastly reviews evidence of dogs at the Bridge River site. Chapters four and five review ancient DNA and stable isotopes respectively; each chapter reviews the development of methodology, interpretation of analysis, and previous results from Bridge River dog artifacts. Chapter seven briefly review the theoretical assumptions used in the study.

Chapter eight covers the methods and materials utilized, and chapter nine the results and statistics. Chapter ten discusses what can be interpreted from the results, the outcome of research questions and hypotheses, and suggestions for future research that should be pursued in the exploration of the relationship between dogs and their human counterparts in early habitation of the Americans. The final chapter, eleven, is a brief concluding statement on the work pursed in the current study and by Anthropology as a whole.

Chapter 2: Environmental and Settlement Review

This chapter reviews the environment and cultural settlements of the British Columbia Interior Plateau. First, a brief discussion on the environment and climate of the Middle Fraser Canyon and how it fits into the British Columbia region and its ecological and climatic history. Next, I provide a review of the people and cultures that inhabited the Middle Fraser Canyon, including how they came to live in this context, a discussion of 'complex hunter-gatherers', and supporting archaeological evidence of the region. Lastly, I outline a comprehensive review of the Bridge River Site, the archaeological and ethnographical data, and the major cultural interpretations it has led to.

Environment and Climate

This study takes place in British Columbia, Canada, a region that shows the greatest diversity of plants, animals, and terrain in all of Canada (Hebda 1995). This diversity can best be shown by the variety of ecological zones. The British Columbia coast is composed of coastal mountain ranges and islands. As one moves inland in the southern portion, the moist environment gives way to the Interior Plateau region and eventually the Northern Rockies that continue into the Alberta Province and down into the United States. In the north, the coastal mountains transition into a region of similar plateaus and mountains. The most northeastern part of British Columbia consists of vast grass plains (Hebda1995). The current study takes place in the Interior Plateau, along the banks of the Fraser River.

The Fraser River meanders from the southeastern border of British Columbia

north to the center of the province and then south to the river's delta in the southwestern-most corner of British Columbia (Figure 1). The Bridge River site is located on the terraces of the Bridge River Canyon only miles from where it feeds into the Fraser River.

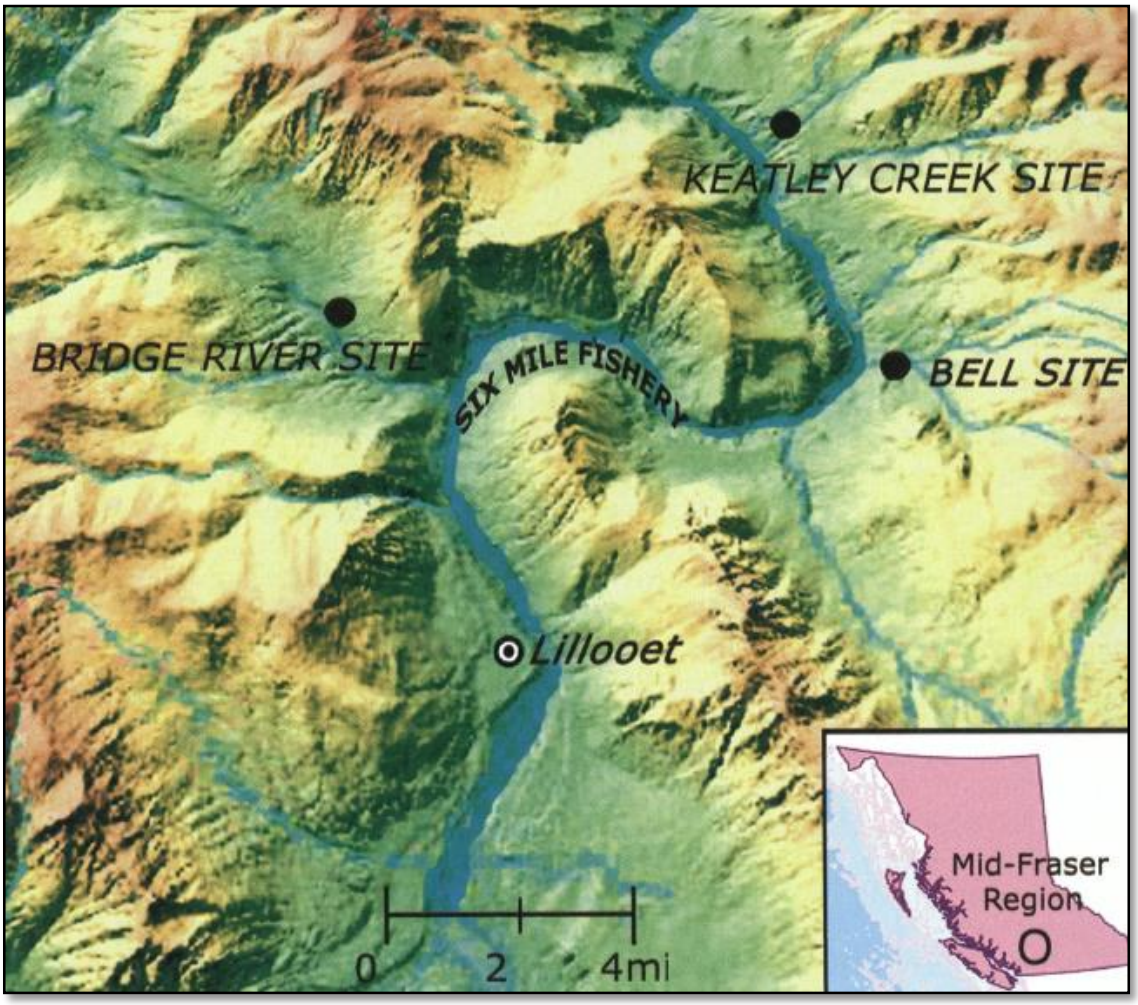

Figure 1 The Fraser River's route through British Columbia, Canada.
Taken from Prentiss et al. 2012

This region originally got its steep sloping valleys from the movement of glaciers in the Pleistocene. Glacial gravel deposits can be found atop the canyon walls, while the lower river walls carve through bedrock (Hayden 1991). During the earlier parts of the Holocene the Canadian interior's climate was considerably drier, with less marked seasonality and poor productivity, making for more favorable conditions on the Northwest coast (Chatters 1998; Hebda 1995; Prentiss and Kuijt 2012)

By ca. 5,000 B.P. the weather started to cool. Termed the Neoglacial period, climates briefly reverted to those reminiscent of the past ice age; nearby forested areas expanded through the interior and productivity in the Bridge River region increased (Chatters 1998; Prentiss and Kuijt 2012). Around 2,500 B.P. the climate warmed again and the modern terrain started to emerge (Chatters 1998; Chatters and Prentiss 2005). Varieties of grasses and berries filled the forest undergrowth, and above them towered Douglas fir and spruce trees (Figure 2). As the elevation gets higher, groves of hemlock and cedars appeared. The highest terrain resembled arctic tundra (Hebda 1995; Prentiss and Kuijt 2012). A variety of wildlife utilized this diverse environment. Many ungulate species, such as mountain goats and sheep in the higher elevations, and elk and mule deer along the canyon terraces. The rivers that flow in and out of the Fraser River house beaver and a seasonally rich supply of salmon (Chatters 1998). Seasonal fires caused much of the environment to be in flux, the result of which was a patchy, resource rich environment (Prentiss and Kuijt 2012).

Figure 2 The Bridge River Valley, taken a few miles upstream of the site and the Fraser River. Photograph by author.

Around 1,200 B.P. the climate did see a slight but influential shift. The climate warmed and caused severe drought and more frequent fires. The melting of glaciers caused more frequent flooding and increased sediment into the rivers, hurting salmon productivity (Chatters 1998; Hallett et al. 2003; Reyes and Clague 2004 as referenced in Prentiss et al. 2006). Through its history, this unique environment has offered its inhabitants a fluctuating supply of both terrestrial and marine products, significantly shaping the lives of past populations.

People of the Middle Fraser River Canyon

The Middle Fraser River region has a rich history of prehistoric housepit communities. Sites of various sizes can be found scattered along the banks of the Fraser River, Bridge River, McKay Creek, and the many other waterways that meander throughout the region (Hayden 1997). The occupation of the Northwest region as a whole has a complex prehistory; this study will focus on a simplified chronology of the cultural traditions that led to the eventual occupation of the Middle Fraser River Canyon.

Beginning in the Middle Period the region saw its first long-term habitation. This was followed by the transitional period of environmental changes in the Neoglacial period, and the formation of the Plateau Pithouse Tradition. This final tradition is composed of the Shuswap, Plateau, and the most recent Kamloops Horizons. These cultural horizons are representative of the southern Canadian Plateau occupations, including the Bridge River village (Richards and Rousseau 1987; Rousseau 2004).

Middle Period. A more sedentary form of settlement in the Northwest Coast and interior plateaus is believed to have started ca. 8,000 years BP. Referred to as the Middle Period these early inhabitants are represented, understood, and their migrations tracked by the unique artifact assemblages they left behind (Prentiss and Kuijt 2012). The interpretation of archaeological assemblages allows anthropologists to peer into the lives of those who live long before us, how they hunted, built shelters, and survived in an ever-changing environment.

Two main cultural traditions existed in British Columbia, the Old Cordilleran, and the Nesikep (Prentiss et al. 2015; Rousseau 2004). The Old Cordilleran tradition is representative term for a variety of cultural traditions descendent from lithic technologies introduced to the new world via the Bering Land Bridge. Other variants of this tradition are the North Coast Microblade tradition, interior Washington Cascade phase, and the southern coast Olcott or Pebble Tool Culture (Prentiss and Kuijt 2012).

More relative to the Canadian Plateau is the Nesikep tradition, known for its microblades, large bifaces, basal or corner notched spear points, and end scrapers. These tools are representative of the Early Nesikep period roughly between 7,000 and 6,000 years BP, occupying some of the same regions as those inhabited by the Old Cordilleran cultures. Descendants of the Early Nesikep tradition founded and overlapped with the Lochnore phase, which is represented in sites between 6,700 to 4,000 years BP. The Lochnore phase was followed by the Lehman phase between 5,800 to 4,800 years B.P. (Prentiss and Kuijt 2004).

The inhabitants who practiced these cultural traditions were highly mobile foragers. This style of hunter-gatherer community structure involved several defining

characteristics: food procurement was done on a day-to-day basis with immediate caloric return, there was little to no storage of food or raw materials, and considerable movement of the entire community took place between different resource areas (Chatters and Prentiss 2005). Around 5,000 year B.P. the climate cooled with the onset of the Neoglacial. Precipitation increased and with it the salmon and mammal populations. This new productivity encouraged further evolution of subsistence strategies and community structure and led into the Platuea Pithouse Tradition. This tradition was potentially influenced by several traditions styles across the Northwest, like the Lochnore phase, Locarno Beach Phase, and the Pithouse II culture, during the Neoglacial period (Chatters and Prentiss 2005; Prentiss and Kuijt 2012).

Neoglacial. Sites occupied in this transitional Neoglacial phase in the Canadian plateau indicate both residential and field camp settlement styles suggesting reduced mobility. The sites in the latter parts of the Lochnore phase shows marked similarities to those in the later Plateau Pithouse traditions; however the people of the Lochnore phase are not solely responsible for all the characteristics of the Plateau Pithouse traditions (Rousseau 2004).

At the Fraser River Delta the Charles culture (cal. 5,500-3,300) also adapted to the changing climate of the Neoglacial period with reduced mobility. This allowed them to take advantage of the temporarily increased productivity of their environment, allowing for some storage and ultimately a better understanding of the increased seasonality of their environment (Pratt 1992; Prentiss and Kuijt 2012). Around 3,500 years ago the Locarno Beach Phase started. Interpreted as a descendant of the Charles

culture, the Locarno Beach Phase was marked by stemmed projectile points, toggle harpoons, and ground slate knives (Matson and Coupland 1995; Prentiss and Kuijt 2012). They now resembled Binford's (1980) collector styled hunter-gatherers with increased group size, sedentism, and harvesting, as well as significant storage with a delayed caloric return (Chatters and Prentiss 2005; Prentiss and Kuijt 2012). The collector adaptation gave the people of the Locarno Beach Phase a selective advantage over their foraging ancestors and possibly motivated the culture's expansion up the lower Fraser River Valley and south down the coast. Evidence suggests this success potentially led to the formation of and successful spread of the Pithouse II culture, a contemporaneous population on the Columbia Basin (Chatters and Prentiss 2005; Prentiss and Kuijt 2012). Both the Locarno Beach Phase and the Pithouse II culture share considerable features with the Shuswap Horizon, the first of the three horizons of the Plateau Pithouse tradition in the Interior Canadian Plateau.

Plateau Pithouse Tradition. The Plateau Pithouse tradition and its corresponding horizons were originally named and characterized by Richards and Rousseau in 1987. The tradition spanned ca. 3,500 years B.P. to 200 years B.P. and was based on shared cultural characteristics in the British Columbia Interior Plateau. As its name implies, the tradition is characterized by semi-subterranean pithouses, which were home to semi-sedentary hunter, gatherer, and fisher groups. The people relied heavily on salmon and practiced considerable storage in underground pits. Despite the overall cultural continuity these horizons share, the evolution and refinement of some of the above characteristics and many others are what define the individual cultural horizons, which are discussed as

follows.

Shuswap. The Shuswap Horizon started ca. 3,500 years B.P. and lasted to ca. 2,400 years B.P. The housepits were typically large with an average of around 10 m diameter (Richards and Rousseau 1987). They had no raised rims and were entered through the side of the housepit, where the roof met the ground, most likely due to a roof constructed without central structural supports. Inside, the homes had storage and cooking features. Projectile points from this horizon showed some distinctive characteristics including triangular shape, stemmed and sometimes concave bases, and rounded corners. The points are interpreted as used in atlatl darts or spear tips. Some microblade technologies have been recovered; flake tools were simple, and scrapers were rare and typically small. Raw material for these tools ranged in quality and very well could be the cause of the 'simplistic' nature of stone tools from this horizon (Richards and Rousseau 1987).

Plateau. The Plateau Horizon started at the end of the Shuswap horizon ca. 2,400 years B.P and lasted to ca. 1,200 years B.P. This patchy, post Neoglacial environment caused groups to seek out and settle in 'ecological hotspots', where various resource areas could be easily reached. To best exploit these 'hotspots,' people of the Plateau Horizon evolved into complex collectors; settlements became larger and highly organized so multiple community tasks like protecting the village, hunting deer, fishing, and gathering berries, could be accomplished simultaneously by different groups within the community. Heavy occupation of the Mid-Fraser region started in the second half of the Plateau horizon ca. 1,600 years B.P. (Prentiss and Kuijt 2012). There, housepits remained large. The homes

showed signs of a several hearths scattered around the circumference of the home, with a central hole in the roof serving for ventilation. This hole most likely also served as the main entrance and exit to the home. This is supported by a lack of side entrances during the Plateau Horizon. Projectile points were barbed and often had corner notches, and the point sizes suggest in addition to atlatl and spear heads, late Plateau Horizon points were also used as arrowheads. Overall the tool assemblage during this horizon showed considerable refinement from the previous Shuswap; craftsmen and women used only the highest quality of raw materials to create finely pressure-flaked, thin unifacial and bifacial tools (Prentiss and Kuijt 2012; Richards and Rousseau 1987). The horizon showed an increase in more decorative bone and antler artifacts, including the advent of composite harpoon valves. People started to use birch bark to form containers and line storage pits. The horizon is also marked by more intensive root gathering as indicated by the recovery of digging sticks (Pokotylo and Froese 1983; Prentiss and Kuijt 2012; Richards and Rousseau 1987).

Kamloops. The Kamloops Horizon lasted from ca. 1,200 years B.P. to 200 years B.P. Housepits grew slightly in size to a mean of 20 meters in diameter, and also started to have noticeable raised rims, with the addition of external storage and cooking features. Stone tools showed similar quality to those in the Plateau Horizon. Stylistically the Kamloops Horizon is known for the 'Kamloops side-notched point', projectile points which, as the name indicates, were notched on the sides rather than the corners (Richards and Rousseau 1987; Stryd 1972). The horizon also showed an increase in ground stone artifacts.

The Mid-Fraser River Canyon was most heavily occupied during the second half of the Plateau horizon and the beginning of the Kamloops Horizon, between ca. 2,000 and 800 years B.P. The most well known sites are Keatley Creek, Bell, and Bridge River.

Between ca. 1,000 years B.P. and ca. 500 years B.P. these larger villages in the Mid-Fraser River Canyon were abandoned. This abandonment or drastic social reorganization was not unique to the area. Abandonments of large settlements are also recorded in the Mid-Columbia region, accompanied by signs of increased violence (Chatters 2004; Prentiss and Kuijt 2012). Similar patterns of warfare and depopulation were seen on the Northern Columbian Basin and throughout the coast and the Fraser River delta. Abandonment or extreme depopulation was clearly not restricted to the Mid-Fraser canyon and reflects a regional trend.

There are potentially several causes for this abandonment. Estimations of population size at Bridge River have suggested a demographic cycle of population growth that the environment eventually couldn't support. Unchecked population growth, combined with over exploitation of key resources and a series of years with low salmon productivity, could have significantly impacted population, leaving abandonment as the only option for struggling communities in the Mid-Fraser Canyon (Prentiss et al. 2014).

Between 500 and 200 years ago, just before the time of European contact several of the larger villages, Bridge River and Keatley Creek, saw reoccupation. Recovered artifacts suggest the new inhabitants lived in a resource rich environment and partook in an extensive trading network as indicated by copper pendants, beads, and jade tools.

Only a few years later, in 1808, European explorer Simon Fraser visited the region to promote trade relations between people in the interior and the coast (Prentiss

and Kuijt 2012). James Teit (1900; 1906; 1909) followed him 100 years later in the 1900's with his extensive ethnographic reports of the Thompson River, Lillooet, and Shuswap Indians. Around the same time, Charles Hill-Tout (1978) also explored the region and collected notable data on various Salish speaking groups on the coast and interior British Columbia. Archaeology in the region has been conducted since 1961 by David Sanger, followed by Arnold Stryd (1980) in the late 60's, Brian Hayden in the 80's-2000's, and most recently Anna Marie Prentiss (Prentiss and Kuijt 2012).

Historically and presently the Bridge River band (Xwisten), a sub-division of the greater St'át'imc Nation, inhabit the region around the site and have been active participants in the archaeological excavation and cultural reconstruction of the Bridge River site and its people.

The Bridge River Site

The Bridge River site is located on a terrace overlooking the Bridge River a few miles up from where it flows into the larger Fraser River. Home to a group of complex collector hunter-gatherers, it was initially established around 1,900 to 1,800 years B.P. and fully abandoned around 1,000 years B.P. University of Montana excavations at the site have been ongoing since 2003 and are composed of 80 different housepits and over 60 external pit features (Prentiss et al. 2008).

The village's occupancy took place during the Plateau and Kamloops Horizons and is divided in to four periods: Bridge River 1 period (BR 1) dated cal. 1,800 to 1,600 cal. B.P. and Bridge River 2 period (BR 2) dated cal. 1,600 to 1,300 cal. B.P. in the Plateau Horizon and Bridge River 3 period (BR 3) dated 1,300 to 1,000 cal. B.P. and

Bridge River 4 period (BR 4) dated 600 to 100 cal. B.P. into the Kamloops Horizon (Prentiss et al. 2008).

During BR 1, when the village was first established the housepits were small and few in number. As time passed and the village grew, so did the homes. Some housepits established early were reused time after time, and the home's structural perimeter grew with the population. The village reached peak occupancy around BR 3, 1,200 to 1,300 years B.P. and then was abandoned, like the rest of the large villages in the area, by about 1,000 B.P. The village was empty for around 500 years, then during the BR 4 period, 500-200 years ago, reoccupied (Prentiss and Kuijt 2012).

The housepits at Bridge River are semi-subterranean, circular, and range from 5-20 meters in diameter. Large posts and beams were installed in the center of the home. Radiating from there to the outside edges of the house, beams were covered with layers of wooden roofing material, vegetative mats, and some type of sediment. The entry to most homes was through a hole in the center of the roof. This location and the low-profile use of a notched log for a ladder made the comings and goings of members undisruptive to other household activities. Waste was removed through the entrance and discarded on the roof and around the base of the home. This type of disposal led to the formation of a rim of midden materials, accumulated and heaped around the external base of the house (Prentiss and Kuijt 2012).

During occupancy, the housepits were likely home to people related by kinship ties (Teit 1906). The homes were single roomed, with different sections of the perimeter space serving separate families social purposes. The interior walls were lined with a

wooden bench for sleeping and built into the floors were various storage and cooking features.

When the house's living floor showed significant wear or accumulated waste, the owners would haul in new sediment to 're-floor' the house; this occurred every 15-25 years (Prentiss et al. 2012). This makes the archaeological excavations of these pithouses particularly useful, as it provides insight into the lives of the occupants of each living floor. When the house's materials and living space showed significant wear, damage, infestation, or simply got too filthy, any salvageable material was removed and the roof burned down and a new roof built and a new floor installed on top (Prentiss and Kujit 2012).

During peak occupancy in BR 3, the village was arranged in a circular pattern, possibly signifying kinship ties, and with a noticeable habitation area divided into northern and southern sections (Prentiss et al. 2012; Prentiss et al. 2014). During this time it is suggested the village had more than 30 occupied homes and could have housed a population of over 1,000 people (Prentiss and Kuijt 2012).

HP 54 is the most heavily excavated house in the Bridge River village. Initial analysis from its the faunal assemblage revealed a significant reduction in salmon, deer, and other large mammals between the BR 2 and BR 3 periods (Carlson 2010). Recent analysis of the house faunal assemblage revealed further insight on taxonomic diversity. The home experienced two periods of increased species predation, the first just prior to the end of the BR 2 period, the second near the end of the BR 3 period, with a reduction between the two. These two time periods are also marked by increased food processing as indicated by bone fragmentation and suspected population increase (Figure 3; Walsh

2015). Changes in the household's subsistence strategies combined with population growth potentially increased competition between houses and aided in the development of social inequality.

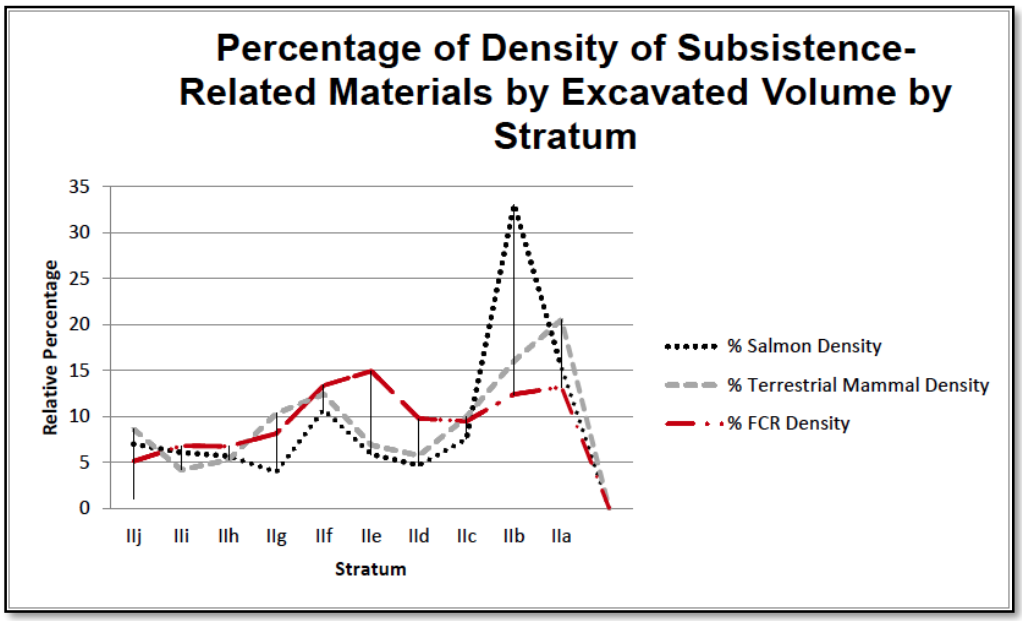

Figure 3 Percentage of Density of Subsistence-Related Materials by Excavated Volume by Stratum. Taken from Walsh (2015) the graph shows two periods of increased subsistence activities around the ends of both the BR 2 and the BR 3 periods.

Analysis of excavations at six housepits, 24, 25, 11, 20, 16, and 54, demonstrated the formation of subsistence and material wealth based indices. Subsistence variability was measured by the number of identified specimen (NISP) of mammals and fish, and from total bifaces recovered. Prestige items like beads, statuettes, vessels, and rare raw material measured material wealth. These items were used to signify social wealth, a physical manifestation of wealth in relation to others in the village. Ultimately these strongly suggested differences in household wealth in BR 3 (Prentiss et al. 2012; Prentiss et al. 2014). This analysis also suggested the village's north area housed wealthier homes than those in the southern area (Prentiss and Kuijt 2012). Some cultural context for this household wealth can be interpreted from Teit's 1906 ethnography of the Lillooet

Indians. He notes the term ‘chief’ was used for individuals who had achieved influence through abundance of wealth or proficiency at special skills. These individuals would host feasts or potlatches, and their status could also be inherited. Teit also mentions material wealth in the form of inheriting property like fishing-stations, dogs, and tools.

Five of the six housepits excavated are sampled in this study. HP 24 and 54 are found in the northern area along with HP 25 which is not used in this study, while HP 11, 16, and 20 are positioned in the southern area (Figure 4). However only housepits 24, 54, 16, and 20 were occupied during the BR 3 period.

HP 24 is a relatively large home, initially excavated in 2008, then continued in 2009. The house was only occupied during the BR 3 period and shows considerable signs of material wealth as well as an invested interest in dogs, indicated by their skeletal remains and the significant amount of coprolites recovered from an interior pit (Prentiss et al. 2009).

HP 54 is a medium sized home around 12 meters in diameter (Prentiss et al. 2009). Occupied in BR 2, 3, and 4, it shows signs of wealth in the BR 3 period. Excavations at HP 54 began in 2008 and have continued on into 2014. It is the most heavily excavated housepit at the Bridge River site (Prentiss et al. 2012; Prentiss et al. 2014).

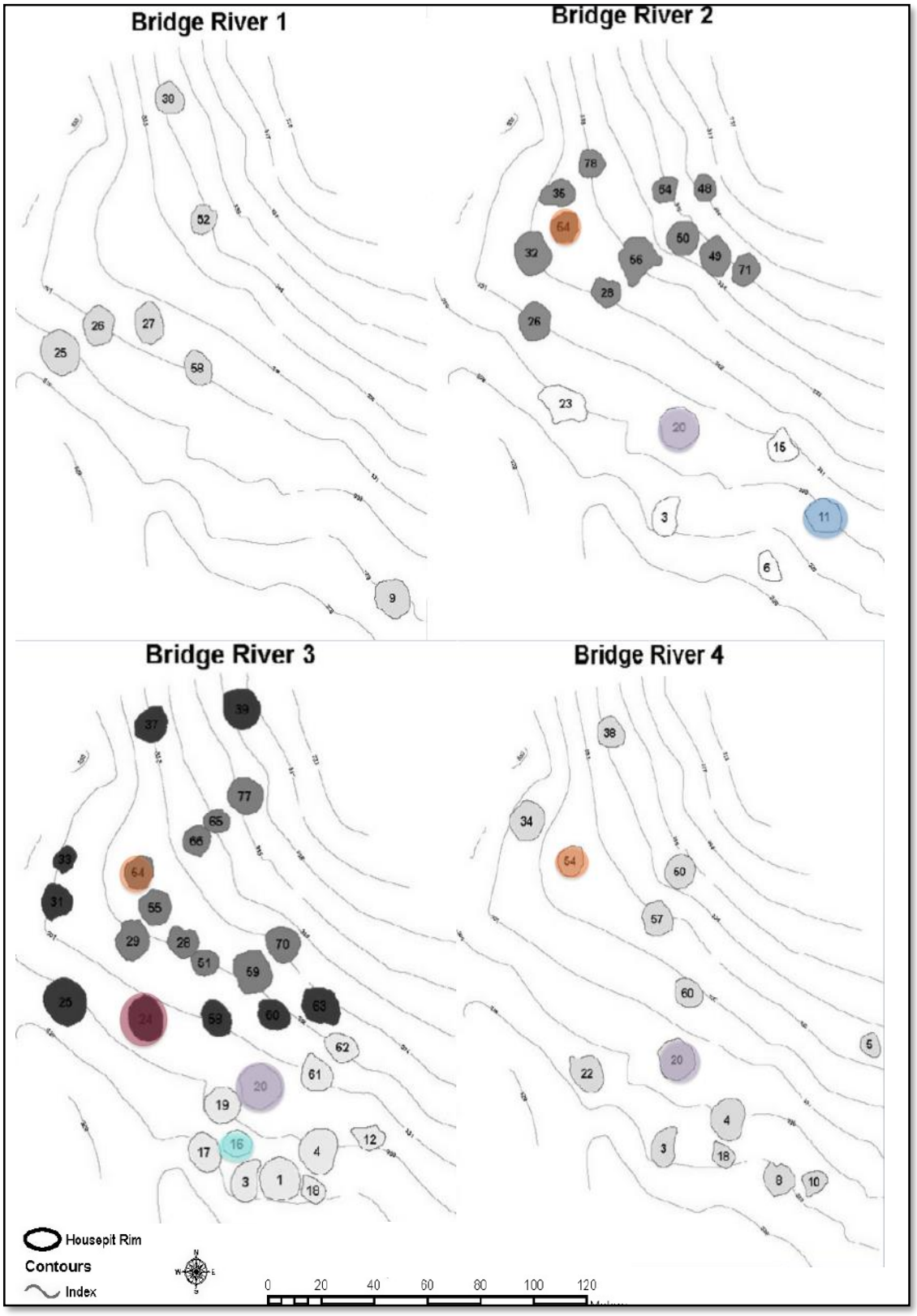

Figure 4 The Bridge River site occupation periods showing village growth and changes in village formation Housepits used in this study are highlighted.

Map by Matt Hogan, taken from Prentiss et al. 2014

HP 11 is a small sized home, around 10 meters in diameter. The house was originally occupied during BR 2. Carbon dating of stratigraphic material puts occupation around 1,630 year cal B.P. (Prentiss et al. 2005). The house shows a thick living floor covered by a single roof. The house was abandoned and reoccupied in the BR4 period (Prentiss et al. 2009).

HP 16 is a medium sized house occupied only during BR 3, radiocarbon dating estimates occupation around 1,305 years cal B.P. (Prentiss et al. 2005). The home contained several floors and two roof replacements. After the last roof was burned, a roasting oven was put in its place.

HP 20, highlighted purple, is a large home approximately 17 meters in diameter, and was occupied during BR 2, 3, and 4. Excavation at HP 20 showed several hearth features and cache pits during the homes BR 2 occupation. However the BR 3 occupation showed mostly cache pits and one feature of unknown use. This variation in feature type resulted in the BR 3 occupation having considerably less fire cracked rock, potentially a signed of decreased house occupancy during the BR 3 period (Prentiss et al. 2009).

Through the efforts of archaeologists through the decades, the lives of the Bridge River people, and all the inhabitence of the greater Northwest region, are more thoroughly understood each year. As the environment changed so did the socioeconomic strategies. This is exemplified in the growth, development, and eventual abandonment of the Bridge River village. Insight on the lives of these people has been uncovered through the excavation of several of the village's housepits, and aided by ethnographic accounts of their and their dog's lives.

Chapter 3: Dogs

The close relationship between humans and dogs is not only observable in everyday life but is also well documented in the archaeological record. The earliest signs of dog domestication or a close human-animal bond go back nearly 33,000 years ago to the heart of the Asian continent. In the Altai Republic a morphologically and genetically distinct dog skull was recovered in a cave along with several other faunal remains. Though no artifacts were recovered with the skull, there were charcoal pieces and burnt bone in the same temporal context (Druzhkova et al. 2013; Ovodov et al. 2011). Approximately 14,000 years ago at the Bonn-Oberkassel site, a dog was found buried with human counterparts, a clear sign of some type of human-animal relationship (Street et al. 2000 as referenced in Morey 2005). Similar burials have been recovered in North America dating back to around 9,000 years B.P. (Keddie 1993). The specific time and location of dog domestication is still up for debate. Like the Out-of-Africa debates of the 1990's, whether or not dogs were domesticated in a single event and then spread or domesticated multiple times in different locations is still hotly debated. Regardless, their role as "man's best friend" goes back centuries (Morey 2005).

This close relationship has prompted archaeological research on the use of dogs as a proxy for paleodiets. Termed the 'canine surrogacy approach' (CSA), this approach is based on the assumption that dogs were fed food scraps from their keepers, and therefore should reflect similar diets (Guiry 2011). The most prevalent use of this approache and the one used in this study is stable isotope analysis. An in-depth review of this approach and similar studies using canine surrogates is discussed in Chapter 5. The review here is

focused on the role of dogs in the Fraser River Canyon and surrounding area as interpreted from ethnographic and archaeological evidence.

Humans have learned to exploit a variety of dog characteristics over the years such as hunting companions, protection, transportation, food, and as a source of raw materials. Linguistic and ethnographic accounts of the Pacific Northwest divide these characteristics between two types of dogs that typically inhabited villages (Crockford and Pye 1997; Schulting 1994; Teit 1900, 1909). The first was the village dog, involved in the more laborious activities. These dogs are said to have resembled coyotes or the Plains Indian dogs (Figure 5; Allen 1920; Teit 1900). The second was what has come to be called the Salish wool dog, maintained for the shearing and processing of their wooly hair. Ethnographic accounts of the Salish wool dog are most prevalent on the coast. Both types of dogs are now extinct with the last known sightings recorded around 1858 (Howay 1918).

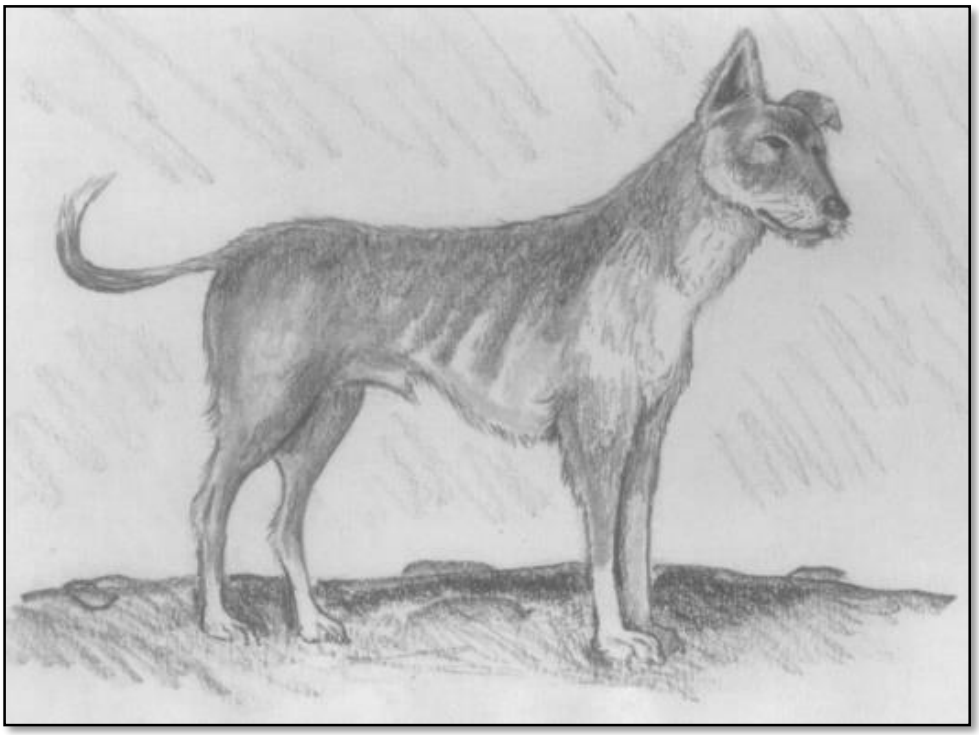

Figure 5. Artistic recreation of village dogs by Camron J. Pye taken from Crockford and Pye (1997).

Salish Wool Dogs

Ethnographic evidence of dog hair used in woven textiles goes back to some of the first coastal contacts near Vancouver Island in 1778. Since then the animal's presence in the Pacific Northwest cultures is well recorded (Howay 1918). The dog hair was often combined with other raw materials like goat or sheep wool retrieved from hunting trips, or fine duck down; the mixed material was then made into yarn and woven into a variety of textiles (Keddie 1993; Solazzo 2011; Teit 1900, 1906). Given the animal's use in textiles, the Salish Wool dogs were also given special treatment and housed within the home, as opposed to the village dogs that were housed outside (Barsh et al. 2002). One of the first physical accounts of the wooly dogs was made in the Puget Sound area of now Northern Washington. Captain Vancouver gives a detailed account of his experience in regards to the appearance and use of dog wool.

> *The dogs belonged to this tribe of Indians were numerous, and much resembled those of Pomerania, though in general somewhat larger. They were all shorn as close to the skin as sheep are in England; and so compact were their fleeces, that large portions could be lifted up by a corner without causing any separation. They were composed of a mixture of a coarse kind of wool, with very fine long hair, capable of being spun into yarn.* (Vancouver 1798:136).

Physical accounts of the wooly dog were also made in the lower Fraser River around Yale and Ruby Creek in 1800's (Howay 1918; Keddie 1993). Accounts like these, along with skeletal evidence, led to the morphological reconstruction of the now extinct dog by Crockford and Pye in 1997. Though the purebred variety of the wool dog is presumed to have gone extinct in the middle of the 19th century, it's likely some hybridization occurred (Figure 6). Hybridization of dogs with coyotes or wolves was noted in ethnographic accounts (Allen 1920; Teit 1900).

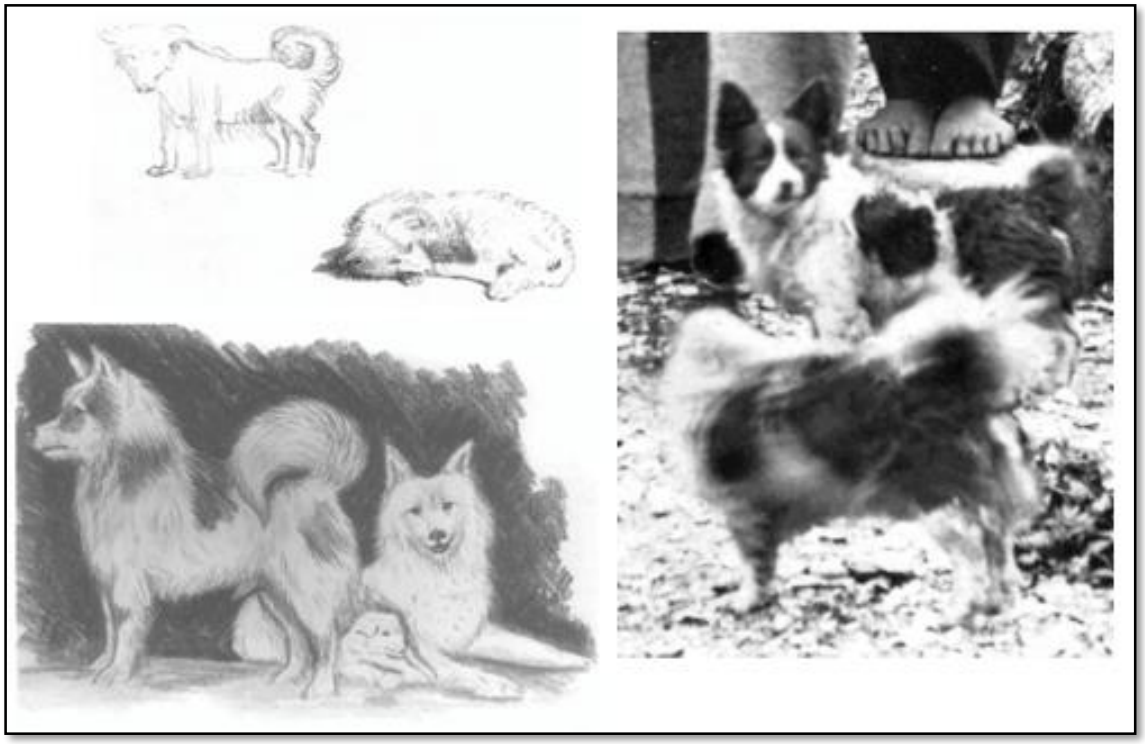

Figure 6 Top Left: Sketch of Salish wool dog by Paul Kane, ca. 1847 taken from Schulting (1994).

Bottom Left: Artistic recreation of Salish wool dog by Cameron J. Pye taken from Crockford and Pye (1997).

Right: Photograph of dogs taken in Smiths Inlet, just north of Vancouver Island. Taken in 1873 the dogs resemble the wool dogs however they also resemble Papillion's. Possibly the result of trading with the Spaniards or hybridization.

By the time of James Teit's ethnographies of the Mid Fraser region these dogs were known to be extinct. However their existence in the interior, as far east as the Middle Fraser River Canyon, is known (Keddie 1993; Teit 1906).

Dogs on the Canadian Plateau

The presence of dogs in the Interior Plateaus is well documented. Ethnographic studies of the region and the analysis of the dog remains found can shed light on the many roles dogs played in the communities. One of the most well known ethnographers of the Canadian Plateau region was James Teit (1900; 1906; 1909). In his many

ethnographies he mentioned the active role dogs played in the community. Most notable was their role in hunting and the use of their hides as a raw material for clothing (Teit 1900; 1906; 1909).

Hunting is vital to these types of societies. An individual skilled in hunting can gain prestige or rise in community status (Cail 2011; Carlson 2010). A well-trained hunting dog could significantly contribute to the link between hunting and social status. Dogs could be used to chase beavers out of dens and holes for easy harpooning and were used for running down bears, caribou, elk, and deer. Well-trained hunting dogs were often fitted with halters and received a high quality of care by their owners, including baths and medicinal supplements, a sign of their value in the community (Crellin 1995; Teit 1906, 1909).

Dog hides were a source of raw material to make different types of garments as well as to make other tools, like quivers or ropes. The use of dog hides in garments were common in the Thompson and Lillooet Indians. However in the Shuswap they were seen as a mark of lower social status, only worn by the poor (Teit 1900, 1906, 1909).

Though Teit's ethnographies provide much information about dogs used in hunting and as a source of raw material, a fair amount of knowledge can also be gained from the analysis of recovered dog remains. An example of this is their use in transportation.

Teit's ethnographies *The Lillooet Indians* and *The Thompson River Indians of British Columbia* he notes dogs weren't used to pull sleds or as pack animals given the mountainous terrain and easy access to waterways for potential transportation. Analysis of the remains recovered at Keatley Creek suggested otherwise (Crellin 1995; Teit 1900,

1906). Skeletal analysis of the vertebral column suggested the dogs were used in some type of packing capacity. Though Teit remarked how the Lillooet and Thompson River groups didn't use dogs as pack animals, he does note their use as such among the nearby Shuswap, Chilcotin, and Carrier (Teit 1909). This is an excellent example of how faunal analysis can help us to better interpret ethnographical accounts. Other roles dogs played in the community, like companionship and protection, are not as easily incorporated into the archaeological record

The companionship and protection dogs offer their owners are their most familiar western roles. Ethnographic accounts of other hunter and gatherer societies in the nearby Kamloops region have suggested dogs could have played a companionship role. In these accounts, companionship was interpreted from the killing of dogs so they may be buried with their owners (Smith 1900 in Crellin 1995). Similar signs are seen among the Shuswap, where a favorite dog would be killed at the grave of their owner and then hung from a tree or pole (Teit 1909). However the companionship role of dogs is extremely subjective. Among the Lillooet, dogs were prized possessions and when their owner died they were passed on as a commodity to the children (Teit 1906). When it came to protection, dogs became guards and could act as a type of early warning system (Crellin 1995). Though this role is well known in western society, Teit (1900) remarks that for the Thompson Indians village dogs made for poor watch dogs.

Dogs have also been suspected as a food source. During his travels through the Mid-Fraser area, Simon Fraser noted they were given dog meat during feasting events (Fraser and Lamb 1960). This suggests the consumption of dogs may have been reserved for special occasions. James Teit (1909) also records the use of dogs in a dog dance ritual

in the Shuswap. He additionally comments they were a back-up food source during hard times. This varies drastically from the Lillooet Indians who were said to eat a considerable amount of dog meat, so much so that dogs were raised for that purpose alone (Teit 1906).

These ethnographic accounts of dogs in late Canadian Plateau communities combined with archaeological context and analysis all aid in the interpretation of dog remains recovered in the Middle Fraser Canyon and the Bridge River site.

Dogs in the Middle Fraser River Canyon

A substantial amount of dog related evidence has been recovered archaeologically in the Middle Fraser region. Remains have also been recovered at the Monte Creek, Bell, Gibb's, East, and Ollie sites in the region; however, little has been interpreted from the context of these (Langemann 1987 in Cail 2011; Wilson 1992 in Hayden 1997). The majority of dog remains and archaeological evidence of their role in the Middle Fraser River Canyon comes from Keatley Creek and the Bridge River Site.

Keatley Creek is located approximately 12 km north of Bridge River off the east bank of the Fraser River. The village consisted of over 100 housepits, and was occupied in some capacity starting around 2,000 years B.P., approximately the same time as Bridge River (Hayden 1997; Prentiss et al. 2003). At the site, partial remains of nine dogs were uncovered in two storage pits, estimated to date to around 1,600 B.P. (Hayden 1997; Prentiss et al. 2003). Most of the remains appeared to be disarticulated before disposal and showed signs of scavenging by other dogs, although one individual was found articulated on the top of the others. In the same housepit, a dog skull was excavated that appeared to have been left or placed in the center of the house before it was burnt. The

recovery of dog remains in the center of living floors prior to burning was also recorded in various other houses at the Keatley Creek site (Hayden 1997). These remains have been interpreted as some type of ritual sacrifice, however no other artifacts related to spirituality or prestige were recovered at the housepit. This suggests natural causes of death or possibly a feasting activity. The use of dogs in rituals and as sacrifices is not unheard of. However it is difficult to interpret from material evidence found at archaeological sites (Crellin 1995). Heavily processed dog bones, highly suggestive of consumption, were also recovered at Keatley Creek in the later period just prior to abandonment.

Dogs at Bridge River were not prevalent in the archaeological record until the 2008 field season, when approximately 179 elements were recovered from two pits in HP 24. The analysis of the remains showed they came from two dogs, and developmental signs indicate that both were below the age of three and one of them was female. These data were combined with 30 other samples of dogs from across the Middle Fraser Canyon to construct a life table, suggesting dogs were at the greatest risk of death between the ages of eight months and two years (Prentiss et al. 2014). The taphonomic analysis of the remains found signs of dismemberment, cut marks, and gnawing. It was also evident the two dogs died at approximately the same time. This has been interpreted as a possible feasting event, a sign of the socioeconomic status of the particular feast holding house (Cail 2011).

A considerable number of coprolites were also recovered from the excavations at HP 24. These underwent aDNA analysis, the results of which were the first of its kind at the Bridge River site and are the foundation for the current study.

Chapter 4: Ancient DNA

Most of the basic characteristics of an organism are coded in its DNA. These codes are inherited from past generations, subject to environmental influences, and include information key to understanding an organism's evolution. However, DNA, like the organism itself, is organic and after death it starts to break down with the body. After death a plethora of factors start to degrade DNA: digestive enzymes in the body, controlled in life, are set free and wreak havoc on the cellular level; as time passes water and oxygen from the body and the surrounding environment aid in the destruction of DNA. Other environmental conditions like heat, radiation, and microscopic organisms can all play a role in the degradation of DNA (Brown and Brown 2011). As DNA degrades it is broken down into shorter linked basepair segments. Despite the challenges presented by this degraded DNA, the analysis of degraded ancient DNA (aDNA) started in the late 20th century.

Anthropological aDNA analysis started in the 1980's with Svante Pääbo (1984) and the extraction and amplification of aDNA from the skin of an ca. 2,500 cal. B.P. Egyptian mummy. The study was exploratory and showed that nucleic acids could be preserved and extracted from archaeological specimens. In 1989, similar methodology was applied to the extraction of aDNA from bone (Hagelberg and Sykes 1989). Since these first few studies the process has been popularized, refined, and made more accessible. aDNA is now utilized in nearly every subfield of biological anthropology and can aid in sex determination, kinship relations, domestication, migration, and much more. Despite its widespread use since its origins, the analysis of aDNA has struggled to overcome one major issue: contamination.

Contamination of an aDNA sample has significant consequences and could lead to false results. Contamination can occur at nearly every point in the history of a sample, from when an organism is buried, to laboratory procedures. Potential contamination at the time of and after burial cannot be prevented, and for this reason is most often simply taken into consideration during analysis. Contamination during excavation and taphonomic analysis can be difficult given the context in which the remains are retrieved; thankfully this issue decreases considerably when dealing with non-human aDNA samples. The targeting of non-human aDNA inhibits the potential amplification of contamination by modern human DNA, however contamination from dog DNA due to excavators or laboratory technicians exposure to modern dogs can still create a complication. Contamination of the sample in the laboratory is considerably more complicated.

Contamination in the laboratory can commonly occur in two ways. The first is during the Polymerase Chain Reaction (PCR) (aDNA amplification) stage. Though this issue again decreases significantly when dealing with non-human aDNA, contamination can still occur from previous PCR's whose amplicons have become airborne and can therefore become unknowingly incorporated into the sample. This can be impossible to detect. However advances in the PCR process and protocols separating the labs for amplified DNA and those for ancient samples decrease the chance of contaminated aDNA significantly. Theses labs are equipped with specialty air filtration units and accidental introduction of contaminants is treated with ultraviolet radiation and bleach washes.

The second possible laboratory contamination can come from laboratory equipment. This problem is also considerably decreased when dealing with non-human aDNA and has been addressed with strict laboratory equipment protocols such as technician attire and conduct (Brown and Brown 2011). Though contamination is a well-known issue with aDNA analysis, researchers, and technicians have made great strides in prevention and remediation. This has led to the increased success of analysis and therefore widespread use of aDNA methods.

The use of aDNA in the study of genetic relationships between groups and individuals is based on mutations and inheritance. Mutations are a base pair change in a DNA sequence that differs between individuals. The tracking of when and where mutations arose allows for the tracing of ancestor-descendent relationships. For the purposes of tracing genetic relationships, the term haplotype is used to refer to a group of individuals with nearly identical genetic mutations. These mutations are inherited as a set and demonstrate a familial relationship between individuals who share them, representing a line of descent. The next level of genetic organization is a haplogroup; this is a set of several haplotypes that all share some of the same genetic mutations and also represent shared ancestry, though on a more distant level than haplotypes. Genetic similarities identified through shared mutations, like haplotypes and haplogroups, can be clustered into clades of various sizes; a clade is a genetic set of all the descendants of a specific ancestor. The size of the clade is based on the ancestor chosen. Clades are often displayed in the form of a branching diagram, where the trunk is the ancestor in question, and each new branch represents the formation of a new distinct variation of that ancestor's genetic signature due to mutation; often haplotypes represent the most specific level of genetic

clades. An organism's genome is inherited from both the mother and father, and therefore the investigation of genetic relationships and the clades they form differ depending on the specific DNA source.

The most commonly used source of aDNA from a sample comes from the mitochondria (mtDNA). The mitochondria are the organelles that manufacture energy in the cell. Each mitochondrion contains multiple copies of their own small, circular DNA molecule, and each cell contains hundreds to thousands of mitochondria. This makes the amount of mtDNA exponentially greater than nuclear DNA, increasing the likelihood of preservation in archaeological samples. MtDNA is inherited only through the matriline, which means it is not recombined with each generation, making it particularly useful in the study of population genetics and matrilineal descent in particular. MtDNA also has a high mutation rate that enables its use in more recent studies of evolution and migration (Stone 2008). For these reason mtDNA has been used in several studies on dog aDNA.

The study of dog aDNA has been used to better understand prehistoric relationships between humans and dogs, most notably the timing and nature of domestication. Through the use of both modern and ancient samples of wolves, coyote, and even fox, mtDNA phylogenetic maps can be made showing genetic relationships between wild and domesticated canids. In the aDNA analysis of dogs the ancestor targeted is typically at the genus level, *Canis.* Once identified, mutations in the sequence can further specify species and sub-species, differentiating between *Canis lupus familiarus* and *Canis lupus lupus*. Lastly the most specific level of mutations can be identified, representing different domesticated dog haplotypes (Figure 7; Barta et al. 2006; Brown et al. 2013; Druzhkova et al. 2013; Ovodov et al. 2011; Witt et al. 2015).

This application can also be used to interpret domestication decisions made by paleo-populations. In a study done by Tito et al. in 2011 on a nearly 9,000 years old dog sample from Texas, mtDNA was used to show the dog remains were rooted within the Eurasian wolf clade, suggesting little to no admixture with prehistoric North American wolves. In another broad study done using dog remains from sites across the New World, samples from British Columbia showed considerable similarity to North American gray wolves, suggesting either a substantial amount of admixture or potentially a second site of domestication (Witt et al., 2015). Dog phylogenetic studies are useful for understanding the domestication process in various locations and as a proxy for human migration. The tracking of dog genetic variation across space leaves a genetic trail; presumably led by their human counterparts, this trail enables anthropologists to interpret human group settlement patterns on a genetic level, even when there are no human genetic sources. Dog aDNA collected throughout British Columbia at sites like Bridge River are an ideal example of this application.

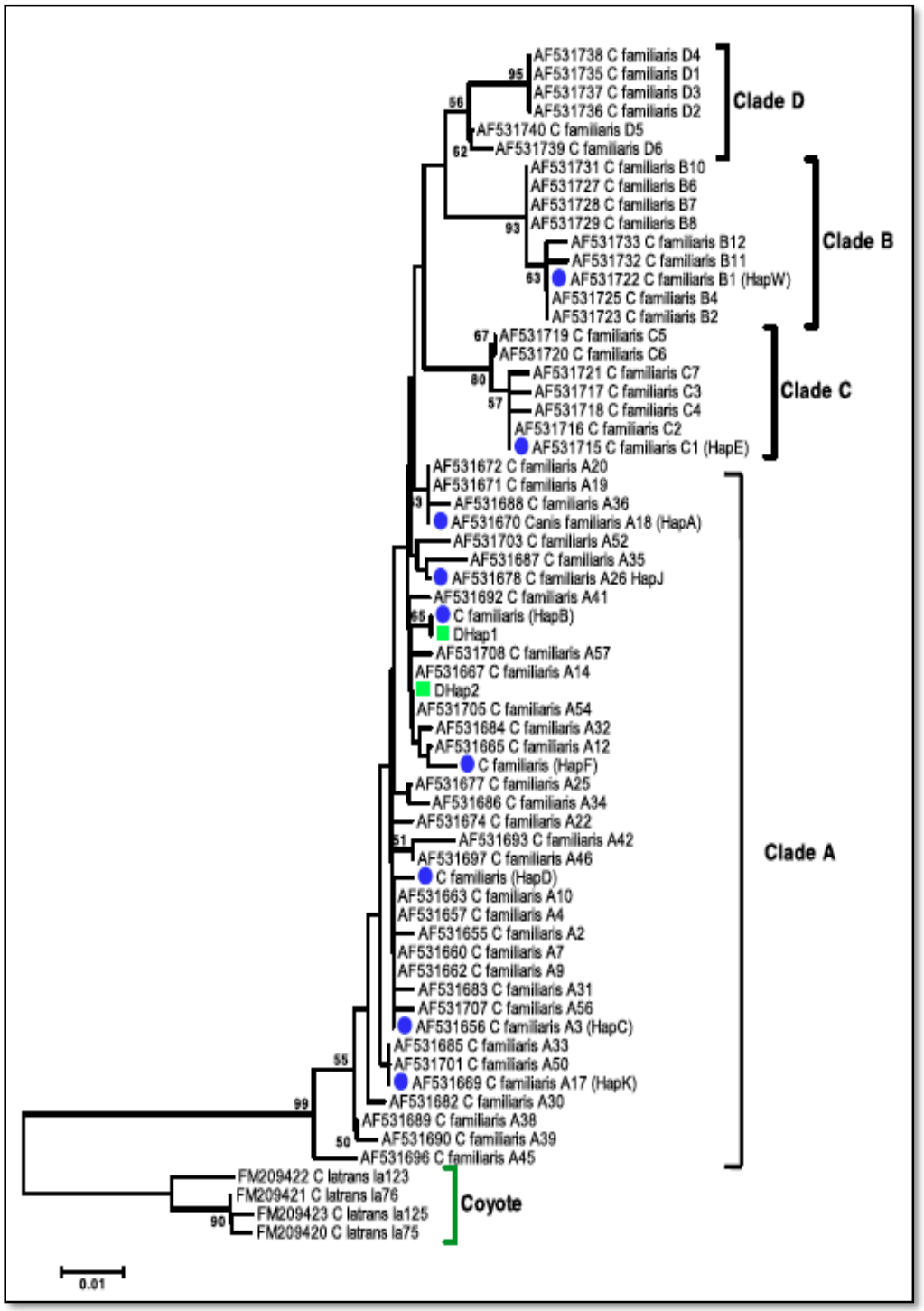

Figure 7 Phylogentic tree showing all clades of domesticated dogs, with genus level relative, the coyote, as an out-group. This tree identifies the genetic relationships between Bridge River samples, green squares, and other NW Coast and Plateau ancient dogs, blue circles. Taken from Barta (2006) Savolainen et al. (2002),Yang et al. (2010).

In the Mid-Fraser Canyon aDNA analysis has only been performed on dog coprolites from Bridge River and from dog remains at Keatley Creek (EeR1-7). At Bridge River a considerable number of dog coprolites were recovered from excavation of both HP 24 and HP 54. Those from HP 24 were used in ancient mtDNA analysis and revealed haplotype D 1 (DHap 1) and haplotype D 2 (DHap 2) belonging to Clade A dogs, originating in Eastern Asia (Figure 7; Cail, 2011; Leonard et al. 2002; Yang et al. 2010). At Keatley Creek, similar results were found, haplotypes, B, D, and F, also part of the East Asian dog Clade A. Keatley Creek haplotype F differed from DHap 2 at Bridge River by only a single base pair, suggesting the dogs at Bridge River came from the same maternal stock as those at Keatley Creek (Barta et al, 2006; Cail, 2011; Yang et al., 2010). These haplotypes inclusion in the Eastern Asian Clade A is indicative of ancient domesticated dogs that were most-likely descendants of those brought over with the first occupants of the Americas (Leonard et al. 2002). Haplotype B and D at Keatley Creek were identical to an older, more northern Namu site (EISx-1) sample, and the contemporaneous Dionisio Point (DgRv-3) and Devil's Run (DgRm-1) sites to the south. The identification of these haplotypes at the Bridge River site suggests groups that traveled through the Fraser River Valley most likely brought dogs to the more southern Dionisio Point site.

Advances in aDNA analysis have allowed for the exploration of human and non-human genetics never thought possible a century ago. The use of dog aDNA in understanding the domestication behavior and as a proxy for human migration has created new venues for genetic anthropological research. As sample numbers increase

and data are added to this phylogeny and others like it, our understanding of paleo-populations will grow.

Chapter 5: Stable Isotopes

Isotopes are variant forms of elements that result from differing numbers of neutrons. First discovered in the early 1900's, isotopes have had a tremendous impact on anthropology. There are two types of isotopes. The first are radioactive isotopes with a known steady decay, which have led to some of the fundamental dating methods used in earth sciences. The second is the non-decaying stable isotopes, which has enabled us to better understand the dietary and migratory patterns in an organism's life. Stable isotopes exist at known atmospheric levels, and an organism's life activities, most notably diet and location, alter these amounts. Over the years, our understanding of how certain types of foods and environmental factors alter these atmospheric amounts has allowed the study of stable isotopes to make inferences on paleo-species diet and mobility. Samples for stable isotope analysis can be collected from several different sources; in archaeology the most common source is bone collagen.

The most prevalent elements used in anthropological stable isotope studies are carbon, nitrogen, and strontium. Carbon stable isotopes are most often used in studies on diet derived from plants, given the abundant use of atmospheric carbon in the process of photosynthesis. There are two carbon stable isotopes that occur naturally, ^{12}C and ^{13}C. Atmospherically, ^{12}C is extremely more abundant than ^{13}C. During carbon fixation, the conversion of inorganic carbon dioxide to organic carbon compounds, this ratio of ^{12}C and ^{13}C shifts significantly to increase ^{13}C. For stable isotopic analysis the change in ^{13}C ($\delta^{13}C$) is assessed through the comparison of the samples $^{13}C/^{12}C$ ratio verses the

international standard. For carbon the standard is the Vienna Pee Dee Belemnite standard (VPDB), and expressed in parts per thousand (‰) using the equation:

$$\delta^{13}C‰ = (^{13}C/^{12}C_{\text{ sample}} \ / \ ^{13}C/^{12}C_{PDB} - 1) \times 1000$$

Given the increase of ^{13}C in plants and therefore the animals that consume them, sample $^{13}C‰$ values are typically expressed as a negative value. These values vary depending on the type of carbon fixation or photosynthetic pathways used by the plants consumed. In this way $\delta^{13}C‰$ signatures can be interpreted to reflect different types of plant consumption, be it from a C3 (more common) or C4 (less common) photosynthetic pathways (Malainey 2011).

The average range of C3 plants is -22 to -34‰, and C4 plants between -8 and -16‰. When using bone collagen for stable isotope analysis, an increase of about 5‰ can be seen from the flora level, C4 and C3 plants, to the secondary consumer level, followed by another 1‰ increase on the tertiary consumer level (Malainey 2011). Given what is known about the environment at Bridge River, this could be modeled by the fresh water aquatic plants as the C3 base, the salmon as the secondary consumer, and humans or dogs as the tertiary consumer. The most well known use of carbon in stable isotopic studies is the investigation into the introduction and propagation of maize, a C4 plant. $\delta^{13}C$ however, is most often shown in relation to the stable isotopic nitrogen (Malainey 2011).

Like carbon, nitrogen is a reflection of the ratio of two nitrogen stable isotopes, ^{15}N and ^{14}N. Atmospheric ^{15}N is typically depleted in relation to ^{14}N. This form of nitrogen gas cannot be readily used by most organisms, requiring conversion of N_2 into a usable form through nitrogen fixation. Nitrogen fixation is the process of converting N_2 into nitrates or other usable chemical compounds; this additional step in the conversion of

atmospheric nitrogen into biological materials is a source of stable isotopic variation (Malainey 2011). Terrestrial plants in the legume family can obtain nitrogen through a symbiotic relationship with *Rhizobium* bacteria attached to the plants roots and the creation of nodules for fixation; similarly in aquatic environments blue-green algae is a nitrogen fixer (Fischer 1994; Kauffman 2013; Schoeninger and Moore 1992). In non-legume plants, nitrates can be obtained directly from the environment; this is only possible due to the bacterial breakdown of nitrogen compounds as a dead organism decomposes. In marine environments nitrogen is made available through bacterial denitrification, resulting in a considerable increase in ^{15}N.

Like carbon, nitrogen stable isotope analysis in interpreted through the change in ^{15}N ($\delta^{15}N$) in the $^{15}N/^{14}N$ ratio of the sample compared to the $^{15}N/^{14}N$ of the international standard. For nitrogen the standard is taken from air (AIR-N_2) and expressed in parts per thousand.

$$\delta^{15}N‰ = (^{15}N/^{14}N_{\text{sample}} \,/\, ^{15}N/^{14}N_{\text{AIR}} - 1) \times 1000$$

Given that air contains 0‰ of ^{15}N, $\delta^{15}N‰$ levels are usually expressed as a positive value (Malainey 2011).

Marine environments show the greatest increase in ^{15}N, typically +17-20‰, freshwater environments are second highest with an increase between 12-17‰, and terrestrial ones +6-12‰. The nitrates use by non-legume plants naturally contain more ^{15}N than the atmospheric nitrogen, causing a slightly more positive $\delta^{15}N$ value than the N_2 fixing legumes and algae; overall terrestrial plants typically show slight enrichment of ^{15}N compared to atmospheric levels (Kauffman 2013; Malainey 2011; Schoeninger and Moore 1992). $\delta^{15}N$ also increases, or accumulates, with each corresponding step up the

trophic ladder, usually +2-3‰ for each step (Malainey 2011). Given some basic knowledge on the typical foraging or hunting behaviors of animals in the region of study, anthropologists can use $\delta^{13}C$ and $\delta^{15}N$ values to distinguish the portions of diet from fresh water or marine fish versus terrestrial herbivores or carnivores. Using the same logic, weaning behavior can also be interpreted from $\delta^{13}C$ and $\delta^{15}N$ amounts, assuming nursing young are a step up the trophic ladder from the mother (Brown and Brown 2011).

Stable isotope values for both carbon and nitrogen were previous performed from two dog rib fragments found at HP 24. Compared with contemporaneous deer and salmon remains, the dog diet indicated the dogs consumed mainly fish, $\delta^{13}C$ values of -15.055% and -15.2335% and $\delta^{15}N$ values 14.4965% and 14.2815%, respectfully (Cail 2011).

The slightly less commonly used stable isotope is strontium. Levels of stable isotopic strontium ^{87}Sr and ^{86}Sr can vary by geographic location depending on the age of nearby rock formations. These geological strontium levels make their way up the food chain and in turn leave indicators of the specific location. When an organism is born the strontium level at their birthplace is imprinted on the inorganic crystalline component of their bone and teeth. Bone however remodels through an individual's life, leading to further incorporation of environmental strontium as the individual may move between different geographic locations. Even further incorporation of environmental strontium into the bone takes place after the animal's death due to the porous nature of bone itself. These factors make bone a more difficult source from which to gather reliable strontium levels when investigating an animal's geographic origin. Teeth contain more mineral components than bone, lack the progressive remodeling feature of bone, and their hard structure makes them less susceptible to contamination; for this reason teeth are preferred

in strontium stable isotope studies on geographic origin (Bentley et al. 2002; Malainey 2011). The comparison of strontium levels of both teeth, marked by an animal's origin, and bone, marked by the location of the final years of an animal's life, can be used to interpret migration patterns (Bentley et al. 2002).

Like stable isotope studies of carbon and nitrogen, strontium samples can be compared to location standards for analysis. Strontium standards taken from bedrock, soils, and water have be known to show considerable variability; therefore focus has shifted from the raw source of strontium to the biologically available strontium levels collected from the bones of small mammals and snails with limited local geographic ranges. Samples of this nature are typically easy to obtain and can be averaged to represent the local standard of biologically available strontium for stable isotopic comparisons (Price et al. 2001). Studies of this type have been used to interpret kinship relations and group migrations. Changes in strontium levels in food sources can also be used to indicate hunting mobility behaviors. If hunters depleted local food sources and were forced to hunt farther away, perhaps in another location with differing strontium levels, this transition could be indicated in the animal's remains (Brown and Brown 2011).

Canine Surrogacy Approach

The majority of research done using stable isotopes in anthropology are applied to human remains and used to investigate human behavior. However human remains are not always available or accessible, which has led to the use of a proxy: their dogs.

The CSA is based on the assumption that domesticated dogs share similar diets to their owners and can therefore be used as a proxy for human diet (Guiry 2012).

Originally started in the 1970's to show the incorporation of maize in Peruvian diets using dog hair, the approach has been refined and popularized over the years (Burleigh and Brothwell 1978). The basic assumption of the approach is that dogs are fed food scraps from their owners and practice caecotrophy, the consumption of feces, resulting in dogs and their human counterparts having shared diets. This assumption however should first be considered with ethnographic evidence of the relationship between dogs and humans for the particular area of study. Ethnographic evidence can provide valuable insight on the relationship of a community with their dogs, potentially clarifying cultural factors influencing the CSA's assumptions. The second consideration is the metabolic process of dogs and humans, and whether diets are isotopically incorporated into the tissues of humans and dogs differently. Both these factors should be considered for the effective use of the CSA and will be discussed in detail below.

There are several types of cultural factors that should be taken into consideration when using the CSA. One of the most important factors is a comparison and consideration of the site's faunal record. Discrepancies between the faunal assemblage and the stable isotope results could have culturally significant implication. In theAmes et al. (2015) study along the lower Columbia, isotopic results from dog remains showed a diet almost exclusively marine based, where the faunal assemblage was considerably more varied. Results of this nature could indicate selective feeding behaviors or potentially active restraint or penning of dogs to limit their scavenging. The more that is known about the community's relationship with dogs the better results can be interpreted.

The assumption that humans and dogs share similar metabolic patterns of tissue isotope incorporation is not well researched independent of the CSA. However the CSA

has been tested on several occasions using bone collagen from both human and dog remains from the same archaeological sites. These tests have concluded that on average dogs are within 2-3% of the $\delta^{15}N$ and $\delta^{13}C$ of their human counterparts, this range however is not consistent between studies and shouldn't be assumed. When differences are between 2-3%, they would be considered statistically significantly distinct, however a small sample size could play a critical role in their analytical recognition (Guiry 2012). The same 2-3% range for human values are assumed at the Bridge River site given the amount of knowledge on human-dog relations in the Fraser River areas. However without comparative human samples this is only speculation. There is no available human data for comparison at Bridge River, and the purpose of this study is to use dog stable isotope analysis as a rough proxy for human diet and subsistence behavior in consideration with trends in the zooarchaeological record.

There is a considerable amount of cultural knowledge about the relationship between humans and dogs in the Mid-Fraser River Canyon and surrounding Canadian Plateau. This evidence suggests that dogs were an active part of village life and likely consumed much of the scraps and leftovers of the community. There is also some ethnographic evidence that dogs may have been consumed as a food source at particular times. The prevalence of dog consumption in a community could influence a trophic level discrepancy in human/dog stable isotopic similarity, increasing human levels by one trophic level comparative to the dogs they consumed (Guiry 2012). When considered with the 2-3% increase assumed for human from dog values, dog consumption would further increase this gap by another 1-2%, reflecting the trophic level effect. In comparison to other cultures that have shown considerable consumption of dogs, Bridge

River shows little evidence of heavy dog consumption (Wing 1978 in Guiry 2012). Though the factor should still be considered, there is not enough evidence that it would significantly alter stable isotopic results from Bridge River. These cultural factors affecting the relationship between dogs and humans in the Fraser River Valley all need to be considered in the use of the CSA.

Chapter 6: Theory

This thesis largely focuses on the cultural insight that biological methodologies can provide when used in an archaeological setting. The previous two chapters briefly reviewed the biological theory behind interpreting stable isotopes, and the evolutionary framework employed when using aDNA to better understand large-scale genetic relationships. The first section of this chapter will summarize the theoretical perspective considered in the cultural interpretation of results. The second section will review the theoretical foundation for understanding and interpreting wealth-based inequality.

Cultural Evolutionary Theory

The goal of this section is to understand the specifics of the cultural evolutionary theory that will be considered in interpreting the results. The section will start with a brief review of the historical development of the theory. Next, the more specific positions of macroevolutionary processual archaeology will be discussed, followed by the role of bauplans and resource management strategies (RMS), and lastly a discussion on how the lives of the dogs at Bridge River can be interpreted under this theoretical perspective.

Theoretical Historical Development. The intersection of an evolutionary theoretical framework and the study of culture is not novel. Since the theory's first applications to anthropology it has borrowed biological evolutionary concepts like selection, drift, and fitness and interpreted them into a cultural context. The link between the understanding of biological processes and anthropology has allowed for aspects of the two subjects to progress simultaneously, however progress is subjective.

Exploration in the 19th and 20th century saw to the considerable expansion of the known range of human diversity on Earth (Mulder, Nunn, and Towner 2006). As theorists attempted to explain this diversity, naturalists started to organize the animal kingdom. This led to the formation of unilinear modes of cultural evolution, where 'primitive' cultures represented the early stages of cultural formations that would eventually evolve into the more civilianized metropolises like those of the European explorers (Tylor 1871). This ethnocentric and racist cultural evolutionary perspective slowly fell out of popularity as time passed. A new perspective on cultural evolution was not explored again until Alfred Kroeber. Kroeber suggested a phylogeny model with splitting branches to represent cultural descent with modification (Kroeber 1948 and 1962). This model has since been elaborated on by several key cultural evolutionary theorists like Durham, Boyd, Richerson, Cavalli-Sforza, Feldman, Barkow, Lumsden, and Wilson (Durham 1990). All of these theorists strive to explain the evolutionary forces that act on human cultures. These processes are interpreted with the aid of basic biological evolutionary concepts.

Macroevolutionary Processual Archaeology. Like biology, anthropology is studied on several scales. Macroevolutionary studies consider large-scale ecological and historical factors that contribute to the dispersal of cultural groups across the globe now and in the past and consider change at a population and generational level. This can take several forms, such as cultural comparisons, linguistics, or archaeology. These all involve the tracing of how cultural traits like languages, tool technologies, or spiritual beliefs evolve across time and space. In archaeology, a site's stratigraphy is a physical record of the past

lives of humans; in this setting, artifacts of varying sizes and types are used to reconstruct cultural lineages and interpret cultural change (Mesoudi et al. 2006).

A macroevolutionary approach to archaeological cross cultural studies can be loosely separated into two distinctive groups: the neo-Darwinians, representing a group of theorists also referred to as evolutionary archaeologists and more specifically 'selections'; and what will be referred to as macroevolutionary processual archaeology (Lyman et al. 1998; Prentiss et al. 2009; Spencer 1997; Zeder 2009). These two groups are often described in relation to the other, and for this reason the best understanding of the macroevolutionary processual archaeology approach must come with an understanding of the neo-Darwinian approach (Zeder 2009).

The neo-Darwinist approach to cultural evolution is based on strict adherence to the basic principles of Darwinian biology. The evolutionary units that selection acts on in this school are human behaviors. These behaviors are transmitted from generation to generation through social learning and imprinted on cultural artifacts (Zeder 2009). The school assumes that agency, or human intentionality, can't be seen in the archaeological record and therefore has no place in theoretical analysis besides its known role in the introduction of variation (Lyman et al. 1998). Neo-Darwinian advocates are focused on identifying the factors behind behavioral selections; these factors are assessed through changing artifact frequencies in the archaeological record. This "focus on artifact-based cultural phylogeny" (Prentiss et al. 2009:3) is a defining feature of the theoretical approach to the study of cultural change. Typically the school is associated with a gradualist, slow and steady, process of undirected cultural change. They do not deny periods of exponential change or development but refute the punctuated model as the

dominant manner of change. Practitioners of the neo-Darwinian school are consistent and uniform in their use of the theory's major tenets; this varies greatly from macroevolutionary processualists (Zeder, 2009).

Like neo-Darwinists, macroevolutionary processual archaeologists are interested in interpreting the archaeological record through a theoretical perspective adapted from biological evolution. Unlike neo-Darwinist, this theoretic approach considers human agency and its role in shaping cultural change as a significant distinction between evolutionary theory's applications in biology verses anthropology (Zeder 2009). This distinction has driven these theorists to adopt a broader, more flexible view of the contributing factors that shape the process of cultural change. The term, first noted by Spencer in his seminal work *Evolutionary Approaches in Archaeology* (1997), *constellation* references the broad interconnected network of differing cultural aspects, like tool construction or dogs as hunting aids, created through human agency; these social aspects shape differences in socio-economic and political strategies, of which selection ultimately acts on. This distinction between neo-Darwinian artifact based cultural traits is best clarified by Spencer, "Processualists tend to see culture not as a collection of traits but as a system populated by willful human actors who are organized into a nested set of organizational levels, such as family, lineage, village, and regional polity" (Spencer 1997:211).

The constellations of alternative cultural sub-structures in the macroevolutionary processual approach are incorporated into larger institutionalized social structures. These basic sociopolitical structures and their role in the theoretical approach are referred to by some as a *bauplan*, (Chatters and Prentiss 2005; Rosenberg 1994; Spencer 1997; Zeder

2009). Adapted from biology, the term is not used uniformly among theorists, but is generally assumed to refer to a type of socio-political, economic, or cultural community structure. The cultural traits that are drawn on to differentiate one bauplan from the other vary depending on theorist and study. Though theorists in this school do consider directionality in the development or change from one bauplan to another, they stress this directionality doesn't mean hierarchal progress or social 'improvement' like the unilinear evolutionist of the 19th and early 20th century. In summary, macroevolutionary processual archaeologists are focused on the development and function of alternative sub structures influenced by human agency which are selected for in the evolution of social systems, or bauplans. At its most basic level this theory acknowledges the unique nature of the human experience without underestimating our essential biological heritage (Spencer 1997).

Bauplane and Resource Management Strategies. The specifics of this approach differ between major theorists of the field, most notably by the details of what defines sub-structures and the general terms used to differentiate buaplans. Here, the Chatters and Prentiss (2005) designation of both will be considered. According to Chatters and Prentiss, baupläne are "characteristic structure[s] of one or more related or unrelated human community's resource management strategies (RMS)" (Chatters and Prentiss 2005:48). Given this focus on resources and subsistence, the two authors employ Binford's (1980) distinction of hunter-gatherers and food producers for general defining terms for bauplane.

Chatters and Prentiss consider the alternative sub-structures that compose a social system as differing resource management strategies (RMS). These are essentially shared ideational ways of environment utilization to fit a community's needs. This includes such things like production, mobility type and frequency, demography, and exchange. RMS sub-structures are defined and identified through the major tools or methods utilized both physically and mentally to best exploit the resources available to a community, in other words, the behavioral manifestations of the RMS shown in the raw material left behind from the tactics utilized, like digging sticks or stone tools. The development and function of these subsistence-based sub-structures are shaped by the human agents employing them and subject to selection. The pattern of their distribution in the archaeological record within and between cultural groups are traces of evolutionary decision-making and thus are shaped and shape each individual culture differently (Chatters and Prentiss 2005). A major strength of this theoretical perspective lays in its versatility. Several factors can be interpreted as behavioral manifestations of a community's means of managing their resources, like dog husbandry.

Dogs as a Tactic. According to Chatters and Prentiss a tactic is "…the behavioral manifestation of the strategy, the level that interacts with the community's environment and is subject to natural selection" (Chatters Prentiss 2005:48). The specifics of a tactic can be used to distinguish and link past cultures, an example of which would be tool types. Specific tool types, like arrow-heads, can be used to show how a community hunted. The manufacture of these tools can be further interpreted to reveal similarities or differences to other groups, linking or distinguishing one from the other. Similarly, the

various ways kept dogs were utilized by a community can be interpreted as a resource management tactic. From ethnographies collected in the Bridge River area, it is suggested that dogs were aids in resource procurement in the form of hunting companions, mobility as pack animals, or as a source of raw material, be it from their hides or hair. Tactics like these can be interpreted from the archaeological record and reflect human decision-making. Dog husbandry could also serve social purposes in a community, as an indicator of social inequality. In this way they aid in the identification of social rank, and potentially the distribution of goods (Chatters and Prentiss 2005).

Inequality

To best understand inequality and the role dogs may play in the identification and holding of social rank at Bridge River, it is first prudent to outline the theory of inequality utilized in the current analysis. Then, inequality at the Bridge River site and the insight dog husbandry can provide as a factor in social rank.

Inequality can exist within a society in several ways and to different degrees. Generally, inequality is the manifestation of some social difference between two or more groups; this difference is imbued with cultural or social meaning, and typically expressed in the rewarding of one group over the others. It is theorized that the underlying cause for inequality between groups or individuals is born out of competition for prestige, ultimately encouraged by the reward of greater reproductive success, much like our primate relatives (Ames 2008). Inequality often results in some form of social status of a group or individual that is recognized by others in the community. Boone (1998) argues social status is "…perceived and acted upon by others in a social group in ways that affect the fitness of all the involved parties" (Boone 1998:5). This can be best shown

when a household with an abundance of resources may choose to be altruistic by hosting public ceremonies like feasts or potlatches. This sharing of resources acts as a display of wealth and as a way to solidify alliances with other members of the community or beyond (Boone 1998).

The theoretical cause and expression of inequality is investigated through the ideation of wealth. In archaeology this must be interpreted from materials that have stood the test of time, and accordingly investigations on inequality utilize objects interpreted as material wealth. Material wealth can be described as any item, like livestock, land, or jewelry, prescribed by a particular culture as 'storing' or representing wealth (Bowles et al. 2009). In the archaeological record some material wealth can be easily identified, like the abundance of non-local goods procured from trade or prestige items like jewelry or statuettes (Kelly 1991; Prentiss et al. 2012). This can also be interpreted from the abundance of food, often seen archaeologically in the form of cooking features and the composition of a faunal assemblage. However, material wealth can also be less tangible and more difficult to identify at an archaeological site. The possession of land, or ownership of reliable resource locations like fishing or hunting locations, or the cultural ramifications that an abundance of food or goods may cause, can be more difficult to interpret and is often supported by ethnographic accounts (Matson 1983; Prentiss et al. 2012).

Inequality at Bridge River. Inequality at Bridge River is best demonstrated in the archaeological record through material wealth. During the Bridge River 3 period, 1,300 to 1,000 cal. B.P, select households demonstrated an accumulation of prestigious items

and raw materials, and non-local raw materials for stone tool manufacture (Prentiss et al. 2012). Both households that showed the greatest material wealth, HP 24 and 54, also had evidence of dog ownership, identified through dog coprolites disposed of in refuse pits in the home. The correlation of material wealth and dogs suggests dogs as a form of material wealth and therefore an indication of status (Prentiss et al. 2014; Teit 1906, 1909). At Bridge River, homes showing increased material wealth have also shown signs of dog ownership. The possession of dogs could influence several aspects of material wealth. Their aid as a hunting companion could affect the abundance of food in a household. They could also be traded for non-local goods, or used in ceremonious feasts hosted by the household in question.

The biological nature of the methodologies used in this study mirror the theoretical framework used in ultimate cultural interpretations. A macroevolutionary processual perspective stresses the socioeconomic decisions made by humans actors. Such decisions shape community structure and the formation and expression of material wealth based inequality.

Chapter 7: Methodology and Materials

The materials used in this study were collected during excavations at the Bridge River site from 2008 to 2014. All samples were identified as *Canis* through morphological comparison. Twenty samples were selected to best answer the research questions posed: the first concerning dog genetic variability, the second variation in diet between homes linked to signs of wealth based inequality, and lastly changes in diet throughout the many occupations of a single household (Appendix A).

These 20 samples were selected out of a small pool of *Canis* skeletal remains and represent approximately 22% of identified *Canis* samples collected from the site. It's assumed this small sample size doesn't contain the full range of variability in all Bridge River dogs. The resulting potential sample bias is a source of decreased precision, potentially poor estimates, and misrepresentation of the population. These factors will be considered during interpretation.

Given the small and un-uniform nature of the samples, two-tailed, un-paired, two sample T- tests of statistical significances will be run on both carbon and nitrogen stable isotope values when applicable. It has been found that a t-test with a sample size as small as two still produce viable results and that Type 1 errors, detecting change when there is none, don't surpass the nominal value of 5% (de Winter 2013) The population from which we wish to draw conclusions is assumed to be normally distributed. Through the use of sample means and standard deviations this test determines if any difference is due to an actual significant difference in the population or simply due to chance. The null hypothesis for each research question will be that there is no significant difference

between the samples. T-values, degrees of freedom, and P-values representing how likely the results are due to chance will be reported.

Thirteen samples were selected from HP 54 from eight separate living floors. Ten of these samples were selected from each of the eight floors and, two extra samples were sent from floors IIb and IIc. These two samples were from the 2013 excavations and specific data such as house unit or area, sample size and weight, fracture type, color, and bone type were not recorded like those samples collected in 2014 (Appendix A). These extra two samples were added opportunistically to increase sample size. The ten main samples were for primary use in the isotope analysis for a floor-to-floor comparison of changes in subsistence pattern in a single household. Seven samples came from BR 3: an ulna fragment from floor IIa, a small (poorly preserved) canine tooth and metacarpal from floor IIb, an ulna and humerus fragment from floor IIc, a fibula fragment from floor IIe, and a tibia fragment from floor IIf. Three samples came from BR 2: a maxillary molar from floor IIh, a (poorly preserved) canine tooth from floor IIi, and a 1st metatarsal from floor IIj.

The three remaining samples taken from HP 54 came from BR 2, floor IIh: an intact axis, cervical, and thoracic vertebra (Figure 8). These samples are assumed to represent a single individual recovered in a pit. The samples represent a small immature dog, distinctive from all other remains recovered. The mtDNA results from these samples are hypothesized to represent a new Bridge River dog haplotype.

Figure 8 Top: All vertebrae recovered from pit in HP 54 IIh floor rearticulated. Bottom, left to right: Axis (sample 10051), Cervical (sample 10050), and Thoracic (sample 10052) Vertebra used in aDNA and Stable Isotope analysis.

Three samples were chosen from HP 24: two left calcanei, ensuring representation of both dogs uncovered from the housepit, and a mandibular canine tooth (Figure 9). These samples together with the samples from HP 54 represent the wealthier households for the research question concerning potential inequality in inter-household subsistence patterns.

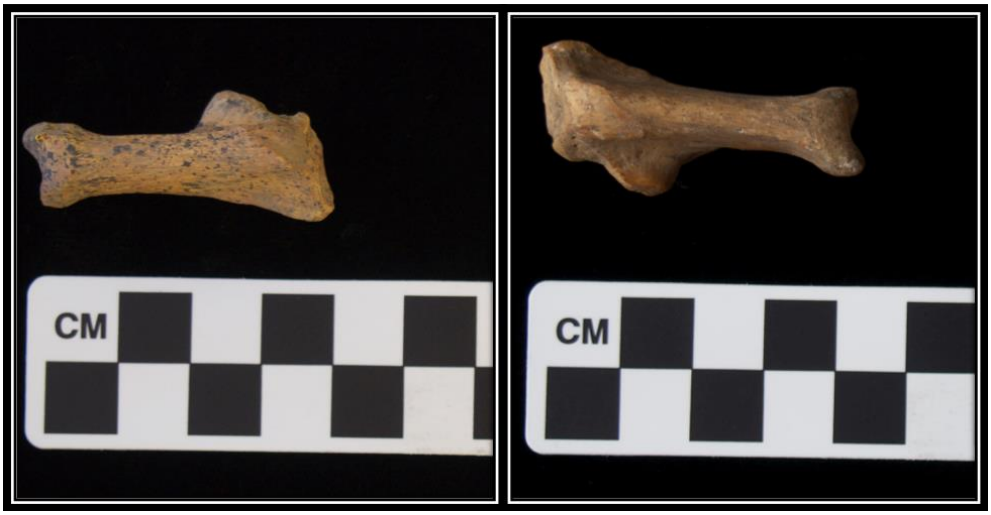

Figure 9 Two Left Calcanei recovered from HP 24, Left: sample 10057, Right: sample 10058.

The less wealthy households will be represented by two samples from HP 20: a fragmented metatarsal and tibia, and one sample from HP 16, a canine tooth. This forms a notably small southern sample.

The last remaining sample was chosen from HP 11, a caudal vertebra, and was chosen as an early BR 2. It was chosen to address the mtDNA research question concerning the Bridge River dogs and their owners early phylogentic relationship to others samples collected in the region.

The samples were sent to the Ancient DNA Laboratory at the Simon Fraser University in Vancouver, British Colombia, and they were received in August 2015. aDNA analysis was performed by experienced Ph.D. student Antonia Rodrigues under the supervision of Professor Dongya Yang over the fall of 2015 (Rodrigues 2015). The lab follows strict contamination prevention protocols. The ancient DNA lab is composed of three rooms, one for bone preparation, a second for DNA extraction, and the last for PCR set up. The lab has a UV filtered and positive airflow ventilation system. Each room has independent equipment as well as individualized full body lab suits. The post-PCR lab is located in a separate building with separate lab attire to aid in contamination prevention (Yang 2015).

Skeletal samples were analyzed with coprolite samples collected in the 2010 and 2014 field seasons, the results of which are beyond the scope of this project and will not be discussed here. All samples were randomly grouped into multiple sets for aDNA extraction; this was done as a means for detecting potential contamination during lab procedures. For DNA testing a portion ranging between 0.183 and 0.704 grams of 10 of the 20 dog skeletal samples was extracted (Table 1). These were then decontaminated in

a bath of sodium hypochlorite (1N HCl and 1N NaOH) and then exposed to UV radiation for 60 min. The samples were then ground into bone powder and digested in a 0.5 M EDTA pH 8.0, 0.25% SDS (sodium dodecyl sulfate) and 0.5 mg/mL proteinase K lysis buffer overnight in a 50°C rotating hybridization oven (Rodrigues 2015).

Skeletal Element	HP	BR Period	Extracted Amount
Ulna	54	3	0.238
Tooth	54	3	0.093
1st Metatarsal	54	2	0.242
Fibula	54	3	0.300
Maxillary Molar	54	2	0.543
Tooth	54		0.183
Tibia	54	3	0.686
Ulna	54	2	0.312
Cervical Vertebrae	54	2	0.704
Thoracic Vertebrae	54	2	0.276

Table 1 aDNA Samples

The samples were then concentrated. Centrifugation separated each sample 2mL of the supernatant were concentrated further to a 100 μL sample using the Amicon Ultra-4 Centrifugal Filter Devices (10KD, 4mL, Millipore) and purified using a QIAquick spin column (Rodrigues 2015; Yang et al. 1998). 100 μL of each purified sample were then eluded for PCR amplification (Rodrigues 2015).

PCR amplification was aimed at two overlapping segments of the *Canis* mtDNA control region with the objective of producing a 345 bp segment of DNA. Three μL of each DNA sample were combined with 1.5X Applied Biosystems™ Buffer, 0.3 μM of each primer, 2 mM MgCl2, 0.2 mM dNTP, 1.0 mg/mL BSA, and 2.5 U AmpliTaq Gold (Applied Biosystems) to compose a 30 μL reaction volume. The solution was then amplified in an Eppendorf™ Mastercycler Personal Thermocycler. A small portion of each product (5 μL) were tested through separation in a 2% agarose gel, utilizing a SYBR

Green™ (Clare Chemical Research Co. USA) indicator on a dark reader (Rodrigues 2015).

Sequencing of successful PCR amplifications were undertaken in Huntsville Alabama by Eurofins MWG Operon. Resulting sequences were reduced to 301bp with the removal of the primer sequences and all bp uncertainties checked with ChromasPro software (www.technelysium.com.au). Resulting sequences were compared to all Genbank sequences through the use of the BLAST application and further compared to all published canid sequences using ClustalW (Thompson et al. 1994) through the online sequence alignment editor BioEdit (www.mbio.ncsu.edu/BioEdit/bioedit.html) (Rodrigues 2015).

After aDNA sampling was performed, the remaining portions of the 20 samples were transported to the Archaeology Isotope Laboratory at The University of British Colombia Vancouver campus. There the samples underwent stable isotopic analysis, focused on carbon and nitrogen levels, by experienced Ph.D. student Alejandra Diaz under the supervision of Professor Michael Richards. Stable isotope analysis interpretations were aided by additional samples of positively identified samples of sockeye salmon (*O. nerka*), rainbow trout (*O. mykiss*), mule deer (*O. hemionus*), sheep (*O. canadensis*), and beaver (*C. canadensis*) from every possible floor from which dog samples were also taken (Appendix B and C).

Sub-samples between 50 and 800 mg were taken from each skeletal sample depending of initial sample size. Subsamples were taken using a diamond surface Dremel cut wheel. Samples were then cleaned by the abrasion of any excess surface material using a dental burr. Samples were then demineralized by submersion in a 0.5 solution of

HCL at 4°C. After sufficient demineralization the excess solution was discarded from each sample and the remaining collagen was gelatinized. Gelatinization was performed over a 48-hour period where the collagen was combined with a pH 3 HCL solution and baked at 75°C. The solubilized collagen was then ultrafiltrated to remove contaminates of lower molecular weight; this was performed by initial filtration through a 60-90μm Ezee® filter, the solution was then centrifuged and contaminates removed and the solution purified through use of a 30kDA ultrafilter. The collagen gelatins were then placed in a freeze dryer for a 48-hour period to be frozen and lyophilized. After sample preparation was complete, sub-samples of 0.5 ± 0.1 mg were run through an Elementar vario MICRO cube elemental analyzer and an Isoprime™ mass spectrometer with use of a carrier gas (Brown et al. 1988; Diaz 2015; Richards and Heges 1999).

Reports of results from the stable isotope analysis were received November 17, 2015 and the aDNA report November 24, 2015. All expenses related to the aDNA and stable isotope analysis are covered under the National Endowment for the Humanities Grant #RZ-51287-11 awarded to Dr. Anna Marie Prentiss and the Bridge River site in 2011.

Chapter 8: Results

Fully successful amplification of *Canis* aDNA and haplotype identification was possible in five out of the ten samples analyzed. One sample was partially amplified and could only be identified as *Canis lupus* (Table 2). Species and haplotype identification was based on identical, or nearly identical, matching of sample sequences with known Genbank *Canis* sequences. A non-match sequence would show significant mutational variation from the known sequences to which it's being compared, and therefore would not be genetically recognizable as belonging to the *Canis* genus or specific known haplotypes. The match of a sequence was ruled out if replicated tests didn't yield the same results. The five fully successful samples matched identically to the Genbank reference sequence of *Canis lupus familiaris* and were identified as mtDNA haplotype D Hap2. The one partially amplified sample could only be identified as *Canis lupus.* Distinction between *C. lupus lupus* (wolf) and C. lupus *familiaris (*domestic dog) was not possible (Rodrigues 2015).

Table 2 aDNA Results

Skeletal Element	Amplification	Species Identification	Haplotype
Ulna	No		
Tooth	Yes	*C.lupus familiaris*	D Hap 2
1st Metatarsal	No		
Fibula	Yes	*C.lupus OR C.lupus familiaris*	
Maxillary Molar	Yes	*C.lupus familiaris*	D Hap 2
Tooth	Yes	*C.lupus familiaris*	D Hap 2
Tibia	No		
Ulna	No		
Cervical Vertebrae	Yes	*C.lupus familiaris*	D Hap 2
Thoracic Vertebrae	Yes	*C.lupus familiaris*	D Hap 2

Stable carbon and nitrogen isotope values were collected from 45 of the 128 samples sent (Appendix D). Quantitative analysis of stable isotope values are condensed to averages and standard deviation (SD) for each species (Table 3) and values displayed on a bi-plot of $\delta^{13}C$ (x axis) and $\delta^{15}N$ (y-axis) (Figure 10). Only one trout sample was analyzed, and its values are reported and shown on the graph.

Table 3 Condensed Stable Isotope Results

Species	n	$\delta^{13}C$		$\delta^{15}N$	
		Average ±SD	Range	Average ±SD	Range
C. familiaris	9	-15.43 ± 0.41	-14.75 − -15.91	14.12 ± 0.54	13.53 − 14.95
C. lupus	6	-20.34 ± 0.39	-19.87 − -20.78	3.75 ± 0.47	3.08 − 4.21
O. canadensis	2	-19.76 ± 0.74	-19.24 − -20.28	4.96 ± 1.15	4.14 − 5.77
O. hemionus	18	-20.82 ± 0.62	-19.30 − -21.74	3.75 ± 0.85	2.04 − 5.88
C. canadensis	2	-20.82 ± 0.15	-20.71 − -20.92	4.43 ± 1.28	3.52 − 5.33
O. nerka	7	-16.08 ± 0.76	-14.68 − -17.03	10.62 ± 1.30	9.66 − 13.22
O. mykiss	1	-16.57		9.61	

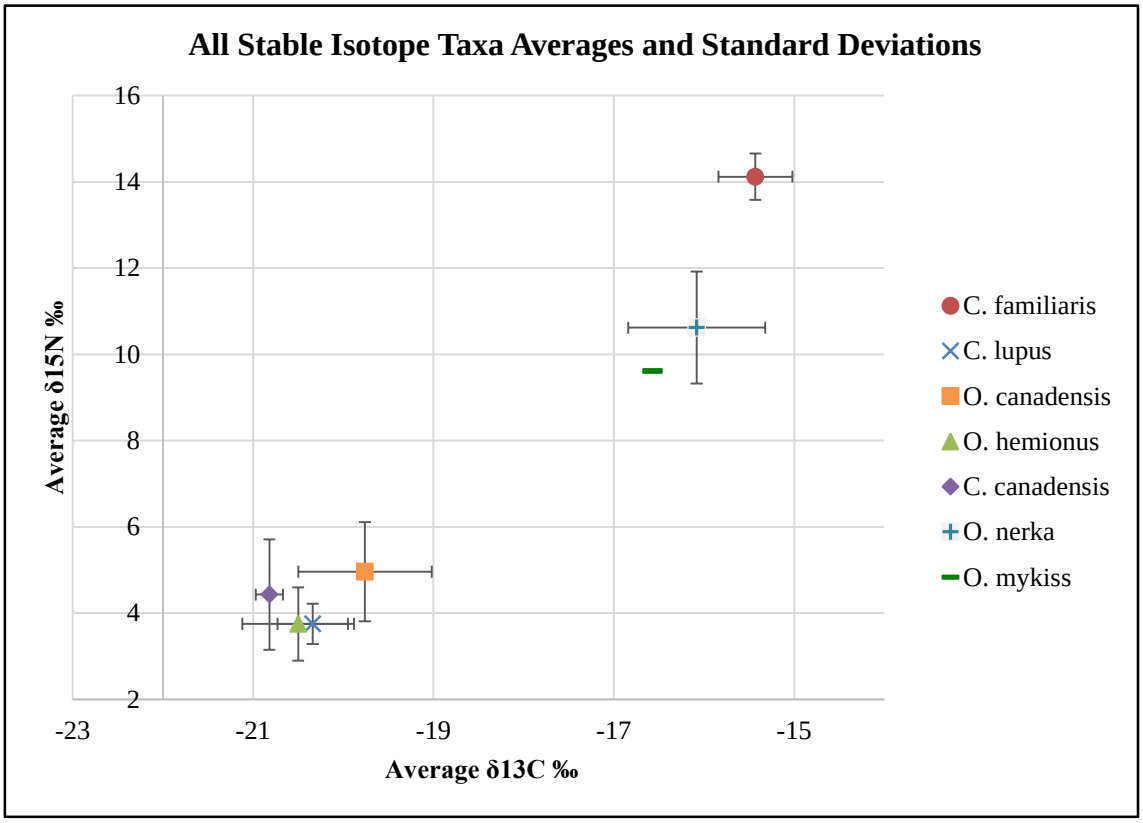

Figure 10 All stable isotope data showing taxas averages and standard deviations.

All samples identified as *Canis* through morphological comparison were separated into two distinct groups with unique stable isotopic values. Nine samples grouped and assumed to represent *C. lupus familiaris* (dog) and had an average δ^{13}C‰ of -15.43, and an average δ^{15}N‰ of 14.12. The remaining six samples were assumed to be *C. lupus lupus* (wolf) and had an average δ^{13}C‰ of -20.34 and an average δ^{15}N‰ of 3.75 (Figure 11). Two tailed t-test for δ^{13}C‰ showed: t=23.1498, df=13, and P-values < 0.0001. The δ^{15}N‰ showed t= 38.2642, df=13, and P-values < 0.0001. This demonstrates the distinction between the samples identified as wolf and dog are statistically significantly different. Only three of the *Canis* samples, cervical and thoracic vertebras and the fibula, had both successful aDNA and stable isotope analysis performed on them.

All three were identified as *Canis familiaris* in stable isotope analysis. The cervical and thoracic vertebras were identified as D Hap2 in aDNA analysis, the fibula was only distinguishable as either *C. lupus of C. familiaris*.

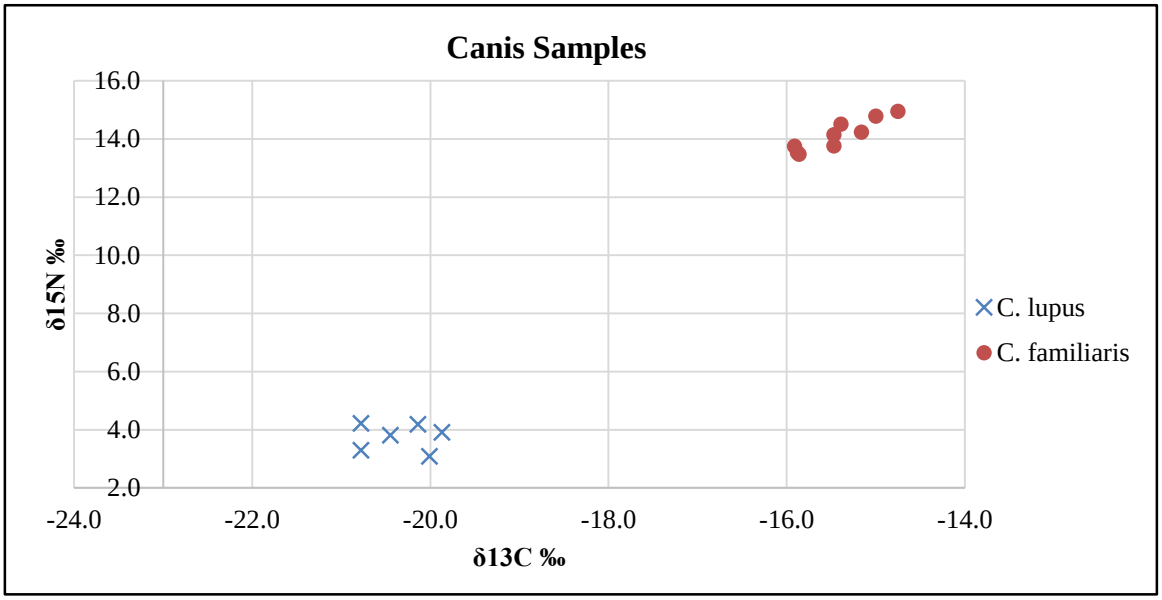

Figure 12 Stable Isotope Values for *Canis* samples showing *C. lupus* and *C. familiaris* differentiation.

The differentiation of wolf from dog further diminished the dog sample size. Only five samples were applicable for the comparison of housepits in the northern verses the southern village. Of these five samples, four represented the northern village from HP 24 and 54, and one from the southern village from HP 20. Due to the limited representation of the southern village, t-tests were not run for this comparison (Figure 12).

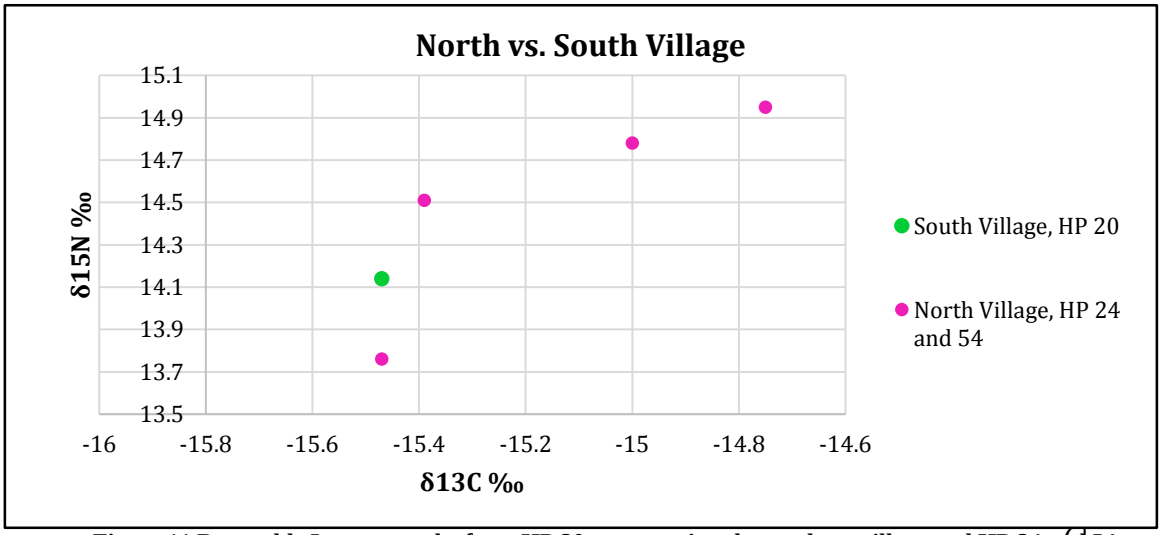

Figure 11 Dog stable Isotope results from HP 20 representing the southern village and HP 24 and 54 representing the northern village.

For the third research question pertaining to change in diet through the many occupations in a single household, HP 54, two analyses were considered. The first attempted to detect change in diet from each floor to the next based on various dog samples. The distinction of dog from wolf significantly inhibited this tactic, providing only eight identifiable dog samples from six of the eight floors. For this reason the tactic was shifted to investigate more broadly any change in diet in a single household between the BR 2 and BR 3 periods. Dog samples were compiled into two groups, BR 2 and BR 3 rather than a floor-by-floor analysis. This is shown on two graphs: the first includes all taxa samples collected from HP 54 (Figure 13), and the second an enlarged view of just the dog samples (Figure 14).

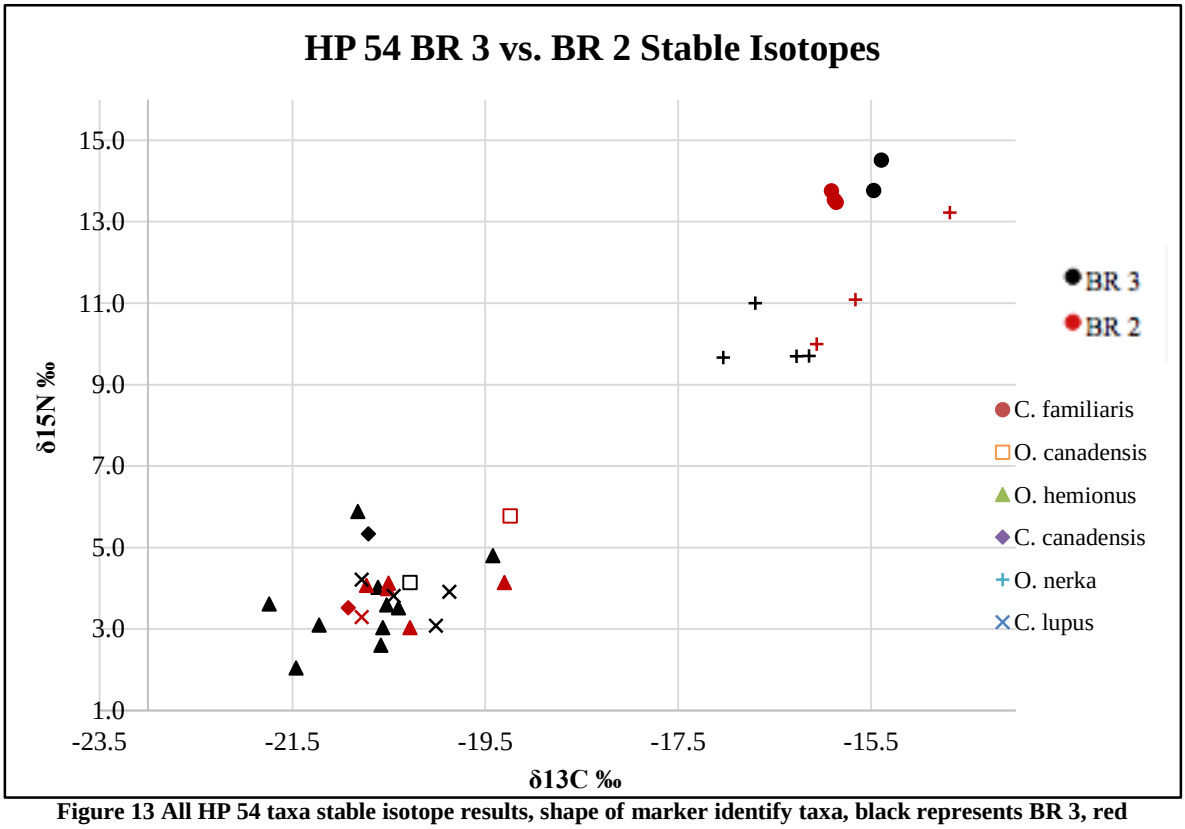

Figure 13 All HP 54 taxa stable isotope results, shape of marker identify taxa, black represents BR 3, red represents BR2.

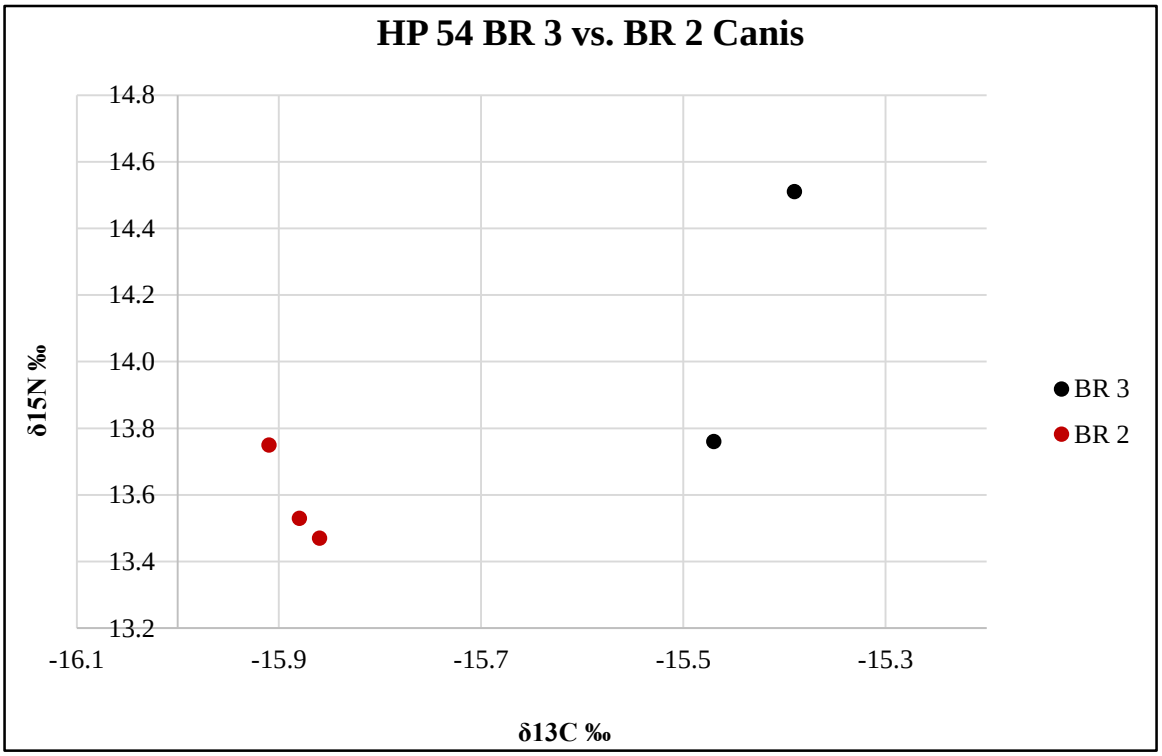

Figure 14 Dog stable isotope results for HP 54, black represents BR 3, red represents BR 2

T-test for the differentiation between dogs in BR 2 and BR 3 had δ^{13}C‰ t-test results of t = 12.8700, df = 3, and P-value < 0.0010, and the δ^{15}N‰ showed t = 1.8369, df = 3, and a P-value of 0.1635. This shows there is a statistically significant difference between the δ^{13}C‰ values from BR 2 and BR 3 samples, but not between the δ^{15}N‰ values.

The second analyses concerning BR periods in HP 54 separated all taxa samples by individual stratigraphic floor. Taxa that had more than one sample representing the floor were averaged for simplicity (Appendix E). Graphs of both δ^{13}C (Figure 15) and δ^{15}N‰ (Figure 16) were created to investigate all faunal stable isotope trends.

Discussion of the aDNA and stable isotope results and what cultural insight they provide about the people and dogs at Bridge River will be completed in the next chapter.

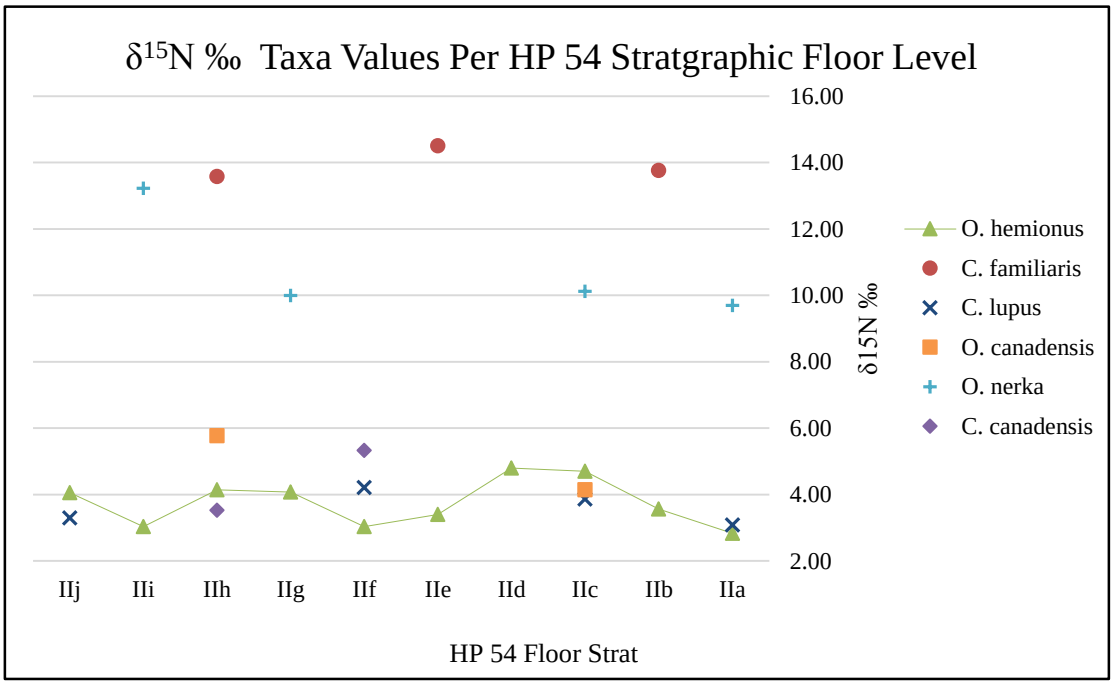

Figure 16 δ^{15}N‰ taxa values per HP 54 stratigraphic floor level; *O. hemionus* was the only taxa that had values for each floor. Floors II j to IIg represent the BR 2 period and floors IIf through IIa the BR 3 period.

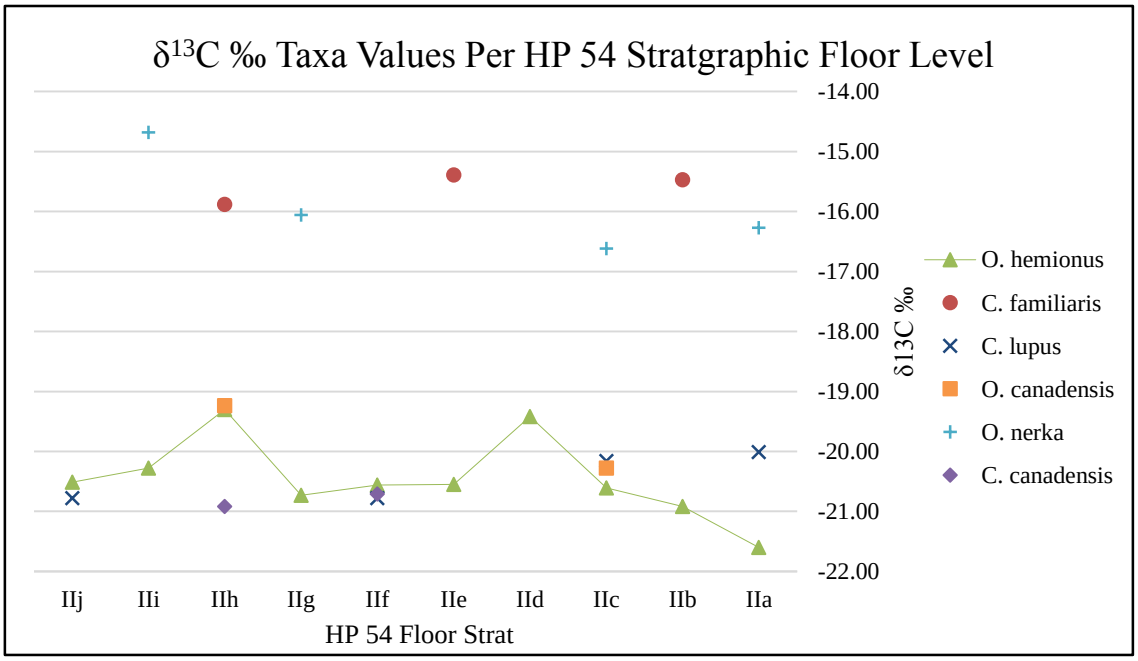

Figure 15 δ^{13}C ‰ taxa values per HP 54 stratigraphic floor level; *O. hemionus* was the only taxa that had values for each floor. Floors II j to IIg represent the BR 2 period and floors IIf through IIa the BR 3 period.

Chapter 10: Discussion

The goal of this study was twofold: first the interpretation of aDNA and stable isotope analysis from dog remains and second what those interpretations say about the people at Bridge River. Three research questions were posed and samples, though small, were selected to address them. As analysis progressed, the sample sizes dwindled, initially by laboratory analysis and lastly through the separation of *Canis lupus* sub-species. The repercussion of the shrunken sample size was a loss of statistical significance and an underrepresentation of the population. However the sample size does not negate all cultural interpretations. This chapter is divided into two sections. Section one is a discussion of aDNA results and their interpretation in addressing the first hypothesis concerning the migration of the Bridge River dogs and their owners. The second section is a discussion of stable isotope results. This is subdivided into four discussions: first an interpretation of all stable isotope results and what they say about the diets of both people and dogs at Bridge River, second the results concerning the first stable isotope hypothesis about diet in the northern and southern parts of the village during BR 3, third the results of the second stable isotope hypothesis concerning HP 54's multiple occupations and the difference between BR 2 and BR 3 periods, and finally a discussion of the application of the CSA at Bridge River.

aDNA

aDNA results from the *Canis* remains all came from HP 54, and the samples belonged to mitochondria haplotype D Hap2. When compared to modern species of dogs, D Hap2 is genetically most closely related to those in Clade A: dogs descended from East Asian wolf stock (Savolainen et al 2002). Clade A was derived from one of the founding haplotypes of dogs in the New World, making Clade A an uniquely Native American dog consistent with the continent's isolation after the disappearance of the Bering Land Bridge (Leonard et al. 2002).

Results of the current study mirrored those previously found, linking the dogs at Bridge River to those of the Northwest coast and some of the first inhabitants of North America. Though the haplotype, and its similarity with those collected from the nearby Keatley Creek, were recognized previously, some of the current results were collected from samples in the earlier BR 2 occupation. This suggests matriline D Hap2 was present in the region longer then previously established. The identification that the D Hap2 lineage spans the BR 2 to BR 3 periods can also be used to interpret the dog's interactions. The prevalence of this matriline at Bridge River could be interpreted to reflect a lack of female dogs being traded or otherwise introduced into the village from the outside; however this interpretation assumes sizable haplotype variation in the region. Given the identification of two other haplotypes, F Hap and B Hap, at Keatley Creek, only miles from Bridge River, some haplotype variation, though potential limited, is suggested for the region. The lack of these haplotypes at Bridge River during the BR 2 and BR 3 occupation suggests limited interaction between the two village's dogs, or a result of small sample size.

This haplotype was also recovered from HP 24 during its occupation in BR 3, linking the two households. This is most likely due to the immediate area containing limited haplotype variation. Bridge River potentially only had the two recognized matrilines of hunting or village dogs, D Hap1 and D Hap2; D Hap1 was only identified from one of the HP 24 dogs in the previous analysis. Further research and the recognition of more matrilines in the village could suggest a speculative relationship between the human occupants of HP 24 and 54.

The first hypothesis concerning aDNA submitted that mtDNA would be amplified and results would be consistent with those in the past. MtDNA was successfully amplified and results were consistent with previous findings. It was also hypothesized the three small vertebrae collected from the IIh pit feature would represent a new mtDNA haplotype identifying the Salish Hair dogs. This was not suggested by the results. The IIh vertebra did not representing a new mtDNA haplotype, however doesn't necessarily mean they were not from a morphologically distinct dog. It does mean the individual was born of the same matriline as the rest of the dogs identified. If hybridization was taking place, it's likely the female dogs were used as vectors for the new breed. Back crossing of wild wolves with domesticated females allows for easier integration of the offspring with those of the other domesticated animals. Practices like this also introduce some genetic variation, reducing the long-term effects of inbreeding (Vila et al 2005). Such breeding practices would of course leave any offspring with the genetics of their mother's domestic matriline.

Though this study didn't result in identification of the Salish Hair dog at Bridge River, future studies still may. Nuclear aDNA analysis of dog remains at Bridge River

could shed further light on dog ancestry. The addition of dog mitochondrial aDNA from other housepits at Bridge River could verify the extent of the D Hap2 matriline in the village as will as the relationship between HP 24 and 54 during the BR 3 period.

Stable Isotopes

Stable isotope results for this study were relatively complete, however the nature of those results had significant impact on their application to the research questions posed. The division of an already small sample of *Canis* remains to even smaller samples of both wolf and dog, significantly hindered the validity of any statistical test for the research questions. Though this is disappointing, it is far from failure. Any statistical values should be taken with a grain of salt and an inquisitive eye. First, general stable isotope results will be discussed, followed by a discussion of the two stable isotope hypotheses concerning the change between households in BR 3 and changes throughout the occupations of HP 54.

Discussion of Faunal Stable Isotope Results. Herbivore samples, the *O. hemionus* n=18 (deer), *O. Canadensis* n=2 (sheep), and *C. canadensis* n=2 (beaver), all had δ^{13}C‰ of around -20 and δ^{15}N‰ around 4.5. These δ^{13}C‰ values are consistent with secondary C3 plant consumers. δ^{15}N‰ suggest a typically terrestrial food sources. In this same isotopic region were the *C. lupus* n=6 (wolf), samples with δ^{13}C‰ average -20.34 and δ^{15}N‰ average 3.75 (Figure 10). The wolf is expected to show a trophic level increase from its major food source, herbivores. Our study fell surprising short. This is likely the first sign of skewed data due to small sample size. Deer samples outnumbered the wolf samples 2:1; however there are other factors that could be responsible for this discrepancy, such

as environmental pressures. Several factors can affect the range of food a pack of regional wolves may have access to. The number of ungulate species in the area can have significant impact of wolves' subsistence. In the case of Bridge River only two are common, and the agility of mountain sheep could make them a difficult prey. In comparison, wolves in northern British Columbia have considerably larger and more versatile prey, like moose, elk, and caribou. Another factor could be the communities of humans living in the area; this creates competition for the wolves, limiting the density and distribution of available ungulate prey. An increased availability of non-ungulate mammals not accounted for in this study, like rabbits or birds, could also account for this isotopic discrepancy (Milakovic et al. 2001).

O. nerka n=7 (salmon), samples had an average δ^{13}C‰ values of -16.08, comparable to previous results, -16.1077, consistent with secondary C3 plant consumers. Salmon had an average δ^{15}N‰ value of 10.62, slightly lower than previous results, 11.5555, and closer to values that would be expected for a secondary terrestrial consumer (Cail 2013).

C. familiaris n=9 (dog), samples had an average δ^{13}C values of -15.43 and an average δ^{15}N‰ value of 14.12. These values reflect a diet primarily composed of fish. The δ^{13}C‰ and δ^{15}N‰ values appropriately reflect trophic level changes from those of the salmon. Human δ^{13}C‰ and δ^{15}N‰ values would be assumed to be similar.

Discussion of Hypothesis Two and Three. The second hypothesis of this study was an investigation into the effects of wealth-based inequality in BR 3. It was predicted that homes in the northern region of the village, which demonstrated increased material

wealth, would have different stable isotopic values reflecting more consumption of potentially prestigious food compared to those homes in the southern region of the village, with fewer signs of material wealth. This hypothesis relied on the use of the CSA, as a means of interpreting human diet from their dogs. This research question was most affected by the decreased sample size. The one remaining dog sample from the southern region of the village made statistical tests of significant inapplicable. Some interpretations can however be speculated based on the $\delta^{13}C‰$ and $\delta^{15}N‰$ bi-plot (Figure 12).

The bi-plot showed the southern sample amongst the northern samples, suggesting no change in stable isotope values due to location. Taken at face value these results could be explained by the nature of dogs. As scavengers, a dog belonging to one household was likely sustained on the scraps of the entire village and not just those of its owners. This would make any isotopic inferences a general reflection of the entire community, and demonstrate heavy salmon consumption.

In consideration of the humans that these *Canine* values are surrogates for, the lack of differentiation between the stable isotopic values of the southern and northern regions of the village may simply reflect similar diets or the lack of recognizable prestigious food consumption. It has been suggested that mammal meat represented the most sought after food, and for that matter, would be linked to signs of wealth (Prentiss et al. 2012). In recent work on the complete faunal assemblage of HP 54, it is suggested that the occupants consumed approximately 50% terrestrial meat and 50% fish (Walsh 2015). However this analysis was based on artiodactyl bone fragments in comparison to mostly whole fish remains, and for that reason is potentially skewed. Were terrestrial meats

consumed at an equivalent rate as fish? The current analysis, and Walsh's conclusions, suggest that only certain terrestrial meats were considered prestigious, and they may not be easily distinguishable in stable isotope values.

Another cultural reason southern and northern regions of the village could reflect a similar stable isotopic value is altruism with food. The sharing of food when hosting a feast or potlatch as a means of cementing community loyalties is well known on the Northwest coast (Barnett 1938).

Given the small sample size of the current study, all interpretations are speculative. Further research on the subject would be best completed with a considerably larger sample size, or through a comparative study using Walsh's (2015) and a similar study of a home in the southern region of the village. Based on the current study, the application of the CSA for this particular research question remains indistinct.

The third and final hypothesis concerning stable isotope values was focused on a single household, HP 54, and the correlation between the faunal record and the dog remains recovered. It was hypothesized that changes in subsistence would be seen as the village undergoes ecological and demographic changes near the end of both the BR 2 and BR 3 periods, and that isotopic values would be complementary with recent analysis of the house's faunal assemblage (Walsh 2015). The unpaired T-test revealed changes in δ^{13}C‰ between dog sample in the BR 2 and BR 3 periods were statistically significant (P value < 0.0010), and that δ^{15}N‰ values were not (P values < 0.1635) (Figure 14). The difference in average δ^{13}C‰ values between BR 2 and BR 3 was 0.43C‰, and while this change may be significant, it is still slight and likely a result of minor climatic changes taking place between the BR 2 and BR 3 periods or an artifact of the limited sample size.

The second assessment of HP stable isotope results involved evaluating all taxa by stratigraphic floor in an attempt to interpret any trends. Deer samples were the most complete and therefore the only taxa viable for trend interpretation. The deer did show a complementary trend to those seen in Walsh's faunal analysis (Figure 17). Both $\delta^{13}C‰$ and $\delta^{15}N‰$ show similar increases and decreases in values. Both had highs at IIh BR 2, and IId BR 3. Both these floors were occupied just prior to periods of population growth. Corresponding $\delta^{13}C‰$ and $\delta^{15}N‰$ lows were seen at IIa, the last occupation of BR 3, and around IIf and IIe, the first occupations of BR 3. These floors are linked to periods of suggested population peaks and increased subsistence activities, represented by fire cracked rock (FCR) and terrestrial mammal densities (Figure 3; Walsh 2015). These slightly lower $\delta^{13}C‰$ could be due to environmental factors affecting the rate of photosynthesis, like the canopy effect. Known to take place in more densely forested areas like the rain and temperate forests, the canopy effect occurs when tall, dense vegetation restricts the flow of air, limiting the amount of CO^2 available for plants and therefore herbivorous animals (Malainey 2011). The increased subsistence activities corresponding to these periods of low $\delta^{13}C‰$ values in the deer could be the result of hunters being forced to hunt deer from more densely vegetated areas outside of their usual hunting range. Floors IIe and IIf are also noted by Walsh (2015) as occupations in which food resources seem to crash, supporting stable isotopic readings that reflect animals being taken from a different ecological area.

Similar environmental factors causing a variation in vegetation, and therefore the process of nitrogen fixation, are likely responsible for the corresponding low $\delta^{15}N‰$ values. Floor IIf deer fragments mostly came from the animal's limbs, suggesting further

travel to acquire the animal (Walsh, 2015). Lower temperatures, high rainfall, or higher altitudes can cause decreased δ15N‰ levels in plants. Likewise, in animal tissues, a decreased δ^{15}N‰ can be caused by cool wet climates or increased access to a water source or obligatory water consumption. These environmental factors support the notion that deer during this period were acquired from a potentially less arid microclimate like a temperate forest outside the hunter's usual range (Ambrose 1991). However, this same link between acquisition distance and environment can not be made for the corresponding low at IIa.

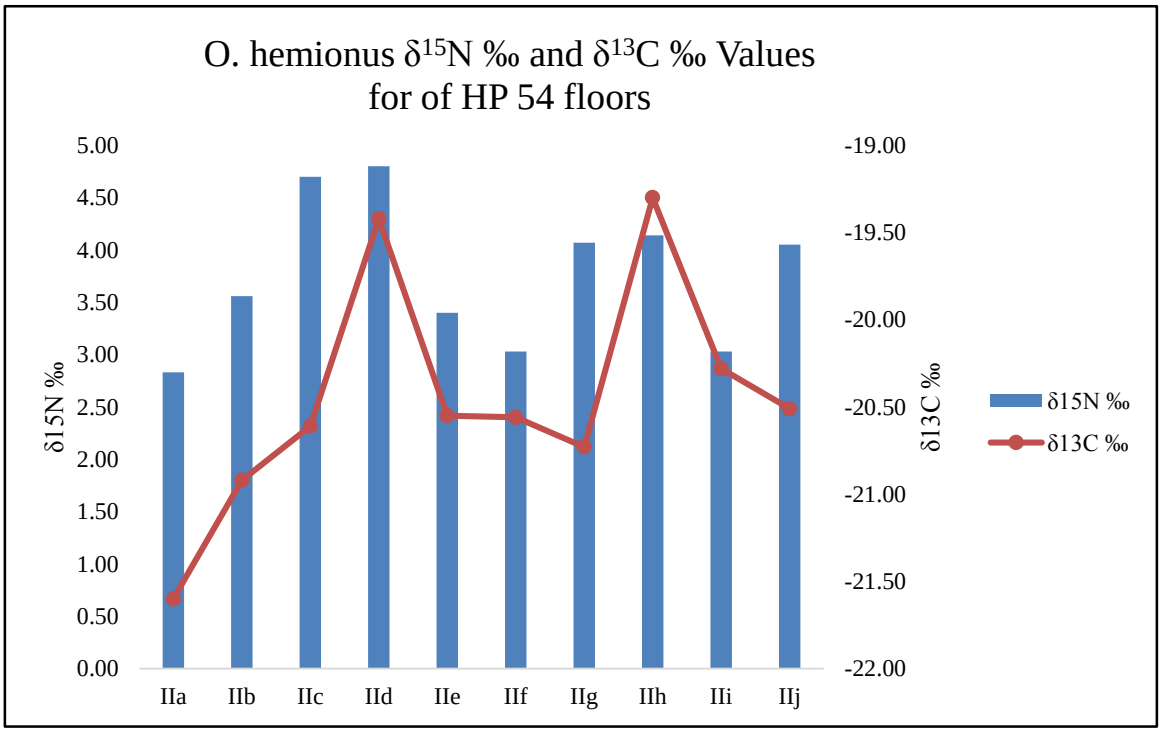

Figure 17 Deer δ15N ‰ and δ13C ‰ values for Floors of HP 54 showing corresponding increases and decreases of values.

IIa deer fragments represented most of the animal, suggesting acquisition was rather easy (Walsh 2015). IIa was the final floor in the BR 3 occupation. Climatically the region saw an increase in temperature, causing an increase in glacial silt and sediment hurting salmon populations. Silt can cause decreased δ^{15}N‰ values in plants, and where

the local deer consuming plants affected by the silt, their δ^{15}N‰ values could be affected. Increased temperature could also promote obligate water consumption also potentially responsible for the decrease in δ^{15}N‰ values (Ambrose 1991).

These stable isotope results provide further support for the changing relationship between the people at Bridge River and the environment surrounding them. Further research on the subject could reveal more substantial evidence for changes in subsistence and their link to social structure. Increased dog samples would allow for more in-depth interpretations of changes in diet between BR 2 and BR 3, or across the entire occupation at HP 54. Strontium stable isotope analysis of the same samples used here could add considerable validity to environmental speculations based on carbon and nitrogen levels. These two hypotheses concerning stable isotope values attempted to extrapolate human behavior and cultural change through the use of the CSA. This was the first application of this approach at the Bridge River site.

The Canine Surrogacy Approach and Bridge River. The CSA is founded on the assumption that dogs eat approximately what their owners do and for that reason can be used as a proxy for human diet. This assumption was tested in this study. Given the considerable ethnographic knowledge on dogs and their relationship with their owners in the Canadian Plateau it was assumed that any values would be relatively easy to interpret, and this may have been the case given a larger sample size. The differentiation between wolf and dog in the *Canis* stable isotope values was unexpected and should be anticipated in future applications at Bridge River. It does however pose some interesting questions about the people at Bridge River and their apparent heavy interaction with wolves. Nearly

half (6/15) of the *Canis* samples retrieved were found to likely be wolf. Five of the wolf samples came from HP 54, four from BR 3 and one from BR 2. The final wolf sample came from HP 20, BR 3. This suggests that wolves played almost as much of a role in the Bridge River community as the dogs did. This can be interpreted as the occasional hunting of wolves for feasting purposes or the capture of them for dog breeding. The wolves were only identified through stable isotopic values, suggesting that if they were captive they were not kept long enough for domesticated feeding habits, the consumption of mostly fish, to be incorporated into their bones. If the wolves were domesticated from a young age, their stable isotopic values would be expected to reflect a diet of mostly fish like the dogs. Further research on the subject is suggested. The results found in the BR 2 vs, BR 3 periods of HP 54 are encouraging for the future application of the CSA, however the number of samples needed, anticipating the prevalence of wolves, may be beyond the scope of the faunal assemblage.

Chapter 11: Conclusion

The present study investigated the relationship between dogs and their human counterparts. Samples were identified as belonging to the genus *Canis* through morphological comparison. Stable isotope analysis showed obvious grouping into two sets with distinctive dietary signatures. One of these groups is assumed to represent domesticated dogs with a diet consisting of mainly fish, much like their human owners. The second group had a diet more consistent with the herbivorous pray of wild wolves. The distinction between these groups was given further credence through aDNA results, with three samples yielding results for both data types; all samples with the domesticated stable isotope motif also belonged to the *familiaris* matriline. The aDNA analysis for all successful samples carried the mtDNA haplotype of D Hap2, and illustrated a lack of diversity of maternal types at Bridge River.

ADNA results provided further evidence of a distinctive Bridge River matriline of domesticated dogs. This identification could indicate a cultural consciousness of dog husbandry and breeding. These results beg further research into the relationship between the people at Bridge River, their dogs, and the surrounding wildlife.

Archaeology and the investigation of past societies have intrigued humans for generations. The search has not just been into what they ate, or how they built their houses, but into how they lived, how they played, grew, and learned; archaeologists dig into the past in search of the path of humanity. The current study was aimed at a better understanding of this path through the use of forensic methodologies and canine surrogates. Results provided more evidence for the lack of variation of dog matriline haplotypes in the Bridge River village and potentially the Middle Fraser River Canyon.

Stable isotope values added further support to archaeological evidence of changing subsistence strategies in response to changing village demographics. Results also encouraged further research into feasting, social inequality, and the relationship between the community, their dogs, and wolves.

This study and others like it strive to gain a better understanding of the complex relationship between the people at Bridge River and the community's interactions with the changing environment around them. Anthropology as a whole investigates why humans behave the way they do, and why some groups are more successful than others. However it's not just to exist that exemplifies the human experience but to live, to better oneself and the world around them, to evolve. Anthropologist know better than anyone it is not human nature to be perfect, it is human nature to learn, and do better next time.

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Date recovered	BR Period	Approx. Date BP	HP	Bag#	ID #	Block/ Area	Unit / Sq	Quad, Sub Sq	Strat	Lv	PPT	Feat.	#	Type	Relative Size	Relative Size, Taxa	Element	Cond.	Size (mm)	Weight (g)	Side	End	Area	Age	Bone Type	Fracture Type	Color	Tap	Cultural Modification	Animal Modification	Length	Width	Thickness	Notes
6/20/14	BR 3	1300-1200 BP	54	384	1	D	12	SW	IIa	2	7		1	Mammalian	Medium	c.f. Canis lupus/latrans	Ulna	Frag.	20-29	0.54	R	Proximal	Semi-lunar notch		Cortical	Spiral/Oblique	Brown	2			20.2	10.2	6.5	Small Dog
6/20/14	BR 3	1300-1200 BP	54	712	1	D	11	NW	IIb	1	133		1	Mammalian	Medium	Canis latrans	Canine tooth	Frag.	20-29	0.09				adult	Enamel		Brown/ Orange	1			11.6	3.9	2.5	Small Dog
2013	BR 3		54	289					IIb					Mammalian	Medium	Canis latrans	Metacarpal																
2013	BR 3		54	319					IIc					Mammalian	Medium	Canis spp	Humerus	Frag.				Distal											
7/5/14	BR 3	1300-1200 BP	54	1361	18	D	16	SW	IIc	1		D-10, lv-2	1	Mammalian	Medium	Canis spp	Ulna	Frag.	20-29	0.45	L		Semi-lunar notch		Cortical	Spiral/ Irregular	Brown	2			22.1	5	5	Compared w/ wolf, large dog
6/9/14	BR 3	1300-1200 BP	54	343	1	B	9	SE	IIe	2		B-3	1	Mammalian	Medium	Canis latrans	Fibula	Frag.	60+	1.45	L	Proximal			Cortical	Transverse	Brown	2			76.7	11.5	3.2	
6/14/14	BR 3	1300-1200 BP	54	555	1	C	11	NW	IIf	1	108		1	Mammalian	Medium	c.f. Canis latrans	Tibia	Frag.	40-49	1.27		Proximal	Tibial Crest		Cortical	Spiral	Brown	2	cut marks	Carnassials puncture mark	39.6	10.6	2.8	
6/13/14	BR 2	1600-1300 BP	54	500	15	A	10.1 1 E, NW	NW/N	IIh	3		A-5, South	1	Mammalian	Medium	Canid	Maxillary Molar	Frag.	20-29	2.52					Enamel/ Cortical		Brown	2			29	21.1	9.5	Big Dog
6/16/14	BR 2	1600-1300 BP	54	557	13	A	10.1 1 E, NW	NW/N	IIh	4		A-5, South	1	Mammalian	Medium	c.f. Canis familiaris	Cervical Vertebra	Whole	20-29	2.77					Cortical	Irregular	Brown	2			24	23.7	11.5	Small Dog, may articulate w/#501, unfused epiphyseal
6/16/14	BR 2	1600-1300 BP	54	557	14	A	10.1 1 E, NW	NW/N	IIh	4		A-5, South	1	Mammalian	Medium	c.f. Canis familiaris	Axis	Whole	20-29	3.42			Spinous Process		Cortical	Irregular	Brown	2		Carnassials puncture mark	27.7	28.1	4.2	Small Dog, may articulate w/ #598, Possible premortum healing on the anterior end of body, unfused epiphyseal
6/11/14	BR 2	1600-1300 BP	54	494	13	A	14.1 5	SE/SW, SW	IIh	1		A-5, Central	1	Mammalian	Medium	c.f. Canis familiaris	Thoracic Vert	Frag.	30-39	0.53					Cortical	Irregular	Brown	2						Small dog
6/17/08	BR 2	1600-1300 BP	54	576		3	9		III	1			1	Mammalian	Medium	Canis	Canine tooth	Frag.	10-19	0.18					Enamel	Irregular	Orange	2						
7/5/14	BR 2	1,400 BP	54	1400	2	A	10.1 4	NW, SW	IIj	1		A-23, lv-2	1	Mammalian	Medium	c.f. Canis lupus	1st Metatarsal	Frag.	10-19	0.5	L	Proximal			Cortical	Irregular	Brown	4			20.3	13	6.1	
6/11/09	BR 2	1619+/-36	11	332		1	1		IIa	1		S, lv-5	2	Mammalian	Medium	Canis	Caudal Vertebra	Whole	20-29	0.87					Cortical		Brown	2						
6/9/09	BR 2	1525+/-39	20	489		3			IId	1		2, lv-8	1	Mammalian	Medium	Canis	Metatarsal	Frag.	30-39	2.57	R	Proximal			Cortical	Irregular/ Transverse	Brown	2	cut marks					
6/11/09	BR 2	1525+/-39	20	323		3			IId	3			1	Mammalian	Medium	Canis	Tibia	Frag.	30-39	2.65	L	Proximal			Cortical	Irregular	Cream	1						
6/3/09	BR 3	1305+/-36	16	209		3			IIb	1			1	Mammalian	Medium	Canis	Canine Tooth	Frag.	20-29	1.15					Cortical	Transverse	Cream							
Date recovered	BR Period	Approx. Date BP	HP	Bag#	ID #	Block/ Area	Unit / Sq	Quad, Sub Sq	Strat	Lv	PPT	Feat.	#	Type	Relative Size	Relative Size, Taxa	Element	Cond.	Size (mm)	Weight (g)	Side	End	Area	Age	Bone Type	Fracture Type	Color	Tap	Cultural Modification	Animal Modification	Length	Width	Thickness	Notes
Period	BR	Approx. Date BP	HP	Bag#	ID #	Block/ Area	Unit / Sq	Quad, Sub Sq	Strat	Lv	PPT	Feat.	#	Type	Relative Size	Relative Size, Taxa	Element	Cond.	Size (mm)	Weight (g)	Side	End	Area	Age	Bone Type	Fracture Type	Color	Tap	Cultural Modification	Animal Modification	Length	Width	Thickness	Notes
3	1300-1200 BP	24	632		3	21		II	1		5 lv-2	1	Mammalian	Medium	Canis	Calcaneous	Whole	40-59	3.85	L				Cortical		Yellow	2						
3	1300-1200 BP	24	443		3	21		II	1		5 lv-1	1	Mammalian	Medium	Canis	Calcaneous	Whole	40-49	6.25	L				Cortical		Yellow	2						
3	1300-1200 BP	24	577	3	30			II	8		5 lv-1	1	Mammalian	Medium	Canis	Canine Tooth	Whole	30-39	1.99	L				Cortical		Yellow	2	cut mark on mandible	Carnassial puncture mark on mandible				Single tooth seperated from mandible being sent for analysis

Appendix B Additional faunal samples from HP 54 to be sent for stable isotope analysis

HP	Bag#	IDF	Block/ Area	Unit/ Sq	Quad, Sub Sq	Strat	Lv	PPT	Feat.	#	Type	Relative Size	Taxa	Element	Cond.	Size (mm)	Weight (g)	Side	End	Area	Age	Bone Type	Fracture Type	Color	Tap	Notes
S4	800	D	D	15	SE	IIa	1	73		1	Mammalia	Large	O. hemionus	Femur	Frag.	60+	4.8			Diaphyseal		Cortical	Spiral	Brown	2	
S4	1451	D	D	15	SW	IIa	1	4		1	Mammalia	Large	O. hemionus	Tibia	Frag.	60+	3.8			Diaphyseal		Cortical	Spiral	Brown	2	
S4	1805	D	D	15	SW	IIb	1	66		1	Mammalia	Large	O. hemionus	Radius	Frag.	60+	2.33	L	Distal	Lateral	Adult	Cortical	Spiral/ Irregular	Brown	2	
S4	1061	D	D	15	SW	IIb	1	122		1	Mammalia	Large	O. hemionus	Tibia	Frag.	30-39	1.64	L		Anterior Crest		Cortical	Spiral	Brown	2	
S4	1183	1	D	15	SW	IIc	1	144		1	Mammalia	Large	O. hemionus	Trapezoid Magnus	Whole	10-19	2.68	L				Cortical		Brown	2	May articulate w/ #1322
S4	1370	1	D	12	SW/SE	IIc	1	175	A-17, 2013 B-14, Lv-1	1	Mammalia	Large	O. hemionus	Metatarsal	Frag.	60+	11.8			Diaphyseal		Cortical	Spiral	Brown	2	
S4	49	8	A	6	SW	IId	1			1	Mammalia	Large	O. hemionus	Pubis	Frag.	40-49	3.35	L			Sub-adult	Cortical	Irregular/ Oblique	Brown	2	Slight blowing on pubis synthisis
S4	44	1	C	14	SW	IIe	3			3	Mammalia	Large	O. hemionus	Thoracic Vert	Frag.	20-29	0.58	L	Proximal	Spinosess Process	Adult	Cortical	Irregular/ Oblique	Brown	2	
S4	394	1	C	9	NE	IIf	1			1	Mammalia	Large	O. hemionus	Phalange	Frag.	20-29	1.42		distal		Adult	Cortical	Irregular/ Oblique	Brown	2	
S4	1342	1	C	11	SW	IIg	1	189		1	Mammalia	Large	O. hemionus	Tibia	Frag.	30-39	3.2	R	Mesial	Diaphyseal	Adult	Cortical	Spiral	Brown	2	
S4	1452	2	C	2	SE	IIg	1	31		1	Mammalia	Large	O. hemionus	Upper Molar M1	Frag.	20-29	1.4	R			Adult	Enamel	Irregular	Brown	2	
S4	847	1	A	10	NE	IIh	1	23		1	Mammalia	Large	O. hemionus	Astragalus	Frag.	30-39	7.3	L			Adult	Cortical	Irregular	Brown	2	
S4	871	1	A	14	SW	IIh	2			1	Mammalia	Large	O. hemionus	Lumbar Vert	Frag.	30-39	7.7			Posterior Body		Cortical	Irregular	Brown	2	
S4	878	1	A	11	NE	IIi	1	49		1	Mammalia	Large	O. hemionus	Astragalus	Whole	40-49	27.7	L				Cortical		Brown	2	
S4	1037	1	A	6	NE	IIi	1			1	Mammalia	Large	O. hemionus	Thoracic Vert	Frag.	30-39	11		Anterior	Vertebral Body	Adult	Cortical	Irregular	Brown	2	
S4	1335	1	A	6	NE	IIi	1	61		1	Mammalia	Large	O. hemionus	Pubis	Frag.	30-39	6.1	L		Acetabulum	Adult	Cortical	Irregular	Brown	2	
S4	1336	1	A	6	NE	IIj	1			1	Mammalia	Large	O. hemionus	Lumbar Vert	Frag.	30-39	3.6			Posterior Body	Adult	Cortical	Irregular	Brown	2	
HP	Bag#	IDF	Block/ Area	Unit/ Sq	Quad, Sub Sq	Strat	Lv	PPT	Feat.	#	Type	Relative Size	Taxa	Element	Cond.	Size (mm)	Weight (g)	Side	End	Area	Age	Bone Type	Fracture Type	Color	Tap	Notes
S4	1193	1	D	16	SW	IIc	1			1	Mammalia	Large	O. canadensis	Tarsal	Frag.	20-29	2.39			Anterior Articular Process	Adult	Cortical	Irregular	Brown	2	
S4	865	1	A	14	SW	IIh	2			1	Mammalia	Large	O. canadensis	Vertebra	Frag.	20-29	4.1				Adult	Cortical	Irregular	Brown	2	
HP	Bag#	IDF	Block/ Area	Unit/ Sq	Quad, Sub Sq	Strat	Lv	PPT	Feat.	#	Type	Relative Size	Taxa	Element	Cond.	Size (mm)	Weight (g)	Side	End	Area	Age	Bone Type	Fracture Type	Color	Tap	Notes
S4	529	10	D	15	NW/ NE	IIa	1			1	Mammalia	Medium	C. canadensis	Lophodont	Frag.	20-29	0.6				Adult	Enamel	Irregular	Brown	2	
S4	1241	5	D	16	NW/ NE	IIb	1			1	Mammalia	Medium	C. canadensis	Lophodont	Frag.	20-29	0.74				Adult	Enamel	Irregular	Brown	3	
S4	367	1	C	7	SW	IIc	1			1	Mammalia	Medium	C. canadensis	Lophodont	Frag.	20-29	0.7				Adult	Enamel	Irregular	Brown	2	
S4	80	1	C	6	SW	IId	1			1	Mammalia	Medium	C. canadensis	Lophodont	Frag.	20-29	0.9					Enamel	Irregular	Brown	2	
S4	346	1	B	5	NE	IIe	1		B-3, Lv-2	1	Mammalia	Medium	C. canadensis	Caudal Vert	Frag.	20-29	1.25					Cortical	Transverse	Brown	2	
S4	553	1	C	15	NE	IIf	1			1	Mammalia	Medium	C. canadensis	Caudal Vert	Whole	10-19	0.5				Sub-adult					
S4	840	1	A	10	NW	IIh	1			1	Mammalia	Medium	C. canadensis	Vertebra	Frag.	10-19	0.6					Cortical	Irregular	Brown	2	
HP	Bag#	IDF	Block/ Area	Unit/ Sq	Quad, Sub Sq	Strat	Lv	PPT	Feat.	#	Type	Relative Size	Taxa	Element	Cond.	Size (mm)	Weight (g)	Side	End	Area	Age	Bone Type	Fracture Type	Color	Tap	Notes
S4	724	1	D	15	SW	IIa	1	32		2	Osteichthye s	Medium	O. nerka	Pre-caudal Vert	Frag.	1-9	0.5					Cortical	Irregular	Brown	2	
S4	424	1	D	11	SW	IIa	1	11		1	Osteichthye s	Medium	O. nerka	Thoracic Vert	Whole	1-9	0.25					Cortical		Brown	2	
S4	1230	3	D	16	NW/NE	IIa	1	203		3	Osteichthye s	Medium	O. nerka	Thoracic Vert	Whole	1-9	0.25					Cortical		Brown	2	
S4	1447	1	D	7	NE	IIc	1	109		1	Osteichthye s	Medium	O. nerka	Thoracic Vert	Whole	1-9	0.16					Cortical		Brown	2	
S4	1250	1	D	16	SE	IIc	1	105		1	Osteichthye s	Medium	O. nerka	Pre-caudal Vert	Frag.	1-9	0.2					Cortical	Irregular	Brown	2	
S4	180	1	C	15	NE	IId	1			2	Osteichthye s	Medium	O. nerka	Thoracic Vert	Whole	1-9	0.16					Cortical		Brown	2	
S4	182	1	C	15	NW	IId	1	13		2	Osteichthye s	Medium	O. nerka	Atlas	Whole	1-9	0.19					Cortical		Brown	2	
S4	182	1	C	15	NW	IIe	1	13		2	Osteichthye s	Medium	O. nerka	Thoracic Vert	Whole	1-9	0.3					Cortical		Brown	2	
S4	599	1	C	15	NW	IIe	1			1	Osteichthye s	Medium	O. nerka	Pre-caudal Vert	Frag.	1-9	0.07					Cortical	Irregular	Brown	2	
S4	599	1	C	13	SE	IIf	2			3	Osteichthye s	Medium	O. nerka	Thoracic Vert	Whole	1-9	0.48					Cortical		Brown	2	
S4	2310	1	A	10	SW	IIh	2			1	Osteichthye s	Medium	O. nerka	Thoracic Vert	Whole	1-9	0.4					Cortical		Brown	2	
S4	1232	3	A	11	SW	IIh	2			3	Osteichthye s	Medium	O. nerka	Pre-caudal Vert	Whole	1-9	0.13					Cortical		Brown	2	
S4	1203	1	A	10	SW	IIi	1			3	Osteichthye s	Medium	O. nerka	Thoracic Vert	Whole	1-9	0.13					Cortical	Irregular	Brown	2	
S4	1405	2	A	10	NW	IIj	1		A-22, Lv 1	2	Osteichthye s	Medium	O. nerka	Thoracic Vert	Whole	1-9	0.6					Cortical		Brown	2	
S4	1405	1	A	10	NW	IIj	1		A-22, Lv 1	1	Osteichthye s	Medium	O. nerka	Pre-caudal Vert	Frag.	1-9	0.19					Cortical	Irregular	Brown	2	
HP	Bag#	IDF	Block/ Area	Unit/ Sq	Quad, Sub Sq	Strat	Lv	PPT	Feat.	#	Type	Relative Size	Taxa	Element	Cond.	Size (mm)	Weight (g)	Side	End	Area	Age	Bone Type	Fracture Type	Color	Tap	Notes
S4	736	4	D	16	SW	IIa	1			1	Osteichthye s	Small	O. mykiss	Caudal Vert	Frag.	1-9						Cortical	Transverse	Brown	2	
S4	831	2	D	15	SW	IIa	1			1	Osteichthye s	Small	O. mykiss	Caudal Vert	Frag.	1-9						Cortical	Transverse	Brown	3	
S4	1200	1	D	15	SW	IIb	1			1	Osteichthye s	Small	O. mykiss	Thoracic Vert	Frag.	1-9						Cortical	Irregular	Brown	2	
S4	1200	2	F	15	SW	IIb	1			1	Osteichthye s	Small	O. mykiss	Thoracic Vert	Frag.	1-9						Cortical	Irregular	Brown	2	
S4	1446	2	D	7	NE	IIc	1	102		3	Osteichthye s	Small	O. mykiss	Thoracic Vert	Whole	1-9	0.06					Cortical		Brown	2	
S4	406	9	C	10	NW	IIf	1		B-3, Lv-2	2	Osteichthye s	Small	O. mykiss	Thoracic Vert	Whole	1-9	0.07					Cortical		Brown	2	
S4	344	4	B	5	NE	IIe	1		B-3, Lv-2	2	Osteichthye s	Small	O. mykiss	Thoracic Vert	Whole	1-9						Cortical		Brown	3	
S4	469	1	A	15	NW	IIh	1		A-5, North	1	Osteichthye s	Small	O. mykiss	Thoracic Vert	Whole	1-9	0.04					Cortical		Brown	2	

Appendix C Additional Stable Isotope Sample for Housepits 11, 16, 20, and 24

HP	Bag#	Block/ Area	Unit/ Sq	Strat	Lv	Feat.	#	Type	Relative Size	Relitive Size, Taxa	Element	Cond.	Size (mm)	Weight (g)	End	Age	Bone Type	Fracture Type	Color	Tap
11	127	1	2	IIb	1	4, Lv-2	1	Osteichthyes	Medium	Oncorhynchus	Thoracic Vert	Whole	1-9	0.12			Cortical		Brown	2
11	127	1	2	IIb	1	4, Lv-2	3	Osteichthyes	Medium	Oncorhynchus	Pre-caudal Vert	Frag.	1-9	0.39			Cortical	Transverse	Brown	2
11	127	1	2	IIb	1	4, Lv-2	1	Mammalia	Medium	C. canadensis	Lophodont	Frag.	10-19	0.34			Enamal	Irregular	Orange	2
11	104	1	2	IIa	4		1	Mammalia	Large	O. hemionus	Lumbar Vert	Frag.	30-39	3.71			Cortical	Irregular	Brown	2

HP	Bag#	Block/ Area	Unit/ Sq	Strat	Lv	Feat.	#	Type	Relative Size	Relitive Size, Taxa	Element	Cond.	Size (mm)	Weight (g)	End	Age	Bone Type	Fracture Type	Color	Tap
16	271	3	4	IIb	1		1	Osteichthyes	Medium	Oncorhynchus	Thoracic Vert	Whole	1-9	0.15			Cortical		Brown	2
16	271	3	4	IIb	1		2	Osteichthyes	Medium	Oncorhynchus	Pre-caudal Vert	Frag.	1-9	0.37			Cortical	Irregular	Brown	2

HP	Bag#	Block/ Area	Unit/ Sq	Strat	Lv	Feat.	#	Type	Relative Size	Relitive Size, Taxa	Element	Cond.	Size (mm)	Weight (g)	End	Age	Bone Type	Fracture Type	Color	Tap
20	490	3	4	IId	1	2, Lv-9	2	Osteichthyes	Medium	Oncorhynchus	Thoracic Vert	Whole	1-9	0.2			Cortical		Brown	2
20	490	3	4	IId	1	2, Lv-9	2	Osteichthyes	Medium	Oncorhynchus	Pre-caudal Vert	Frag.	1-9	0.16			Cortical	Irregular	Brown	2
20	490	3	4	IId	1	2, Lv-9	1	Mammalia	Medium	C. canadensis	Lophodont	Frag.	20-19	0.61			Enamal	Irregular	Orange	2
20	328	3	3	IId	1	5, Lv-2	1	Mammalia	Large	O. hemionus	Lumbar Vert	Frag.	40-49	7.59		Sub-adult	Cortical	Irregular	Brown	2

HP	Bag#	Block/ Area	Unit/ Sq	Strat	Lv	Feat.	#	Type	Relative Size	Relitive Size, Taxa	Element	Cond.	Size (mm)	Weight (g)	End	Age	Bone Type	Fracture Type	Color	Tap
24	445	3	5	IIa	1	1-4, Lv-2	5	Osteichthyes	Medium	Oncorhynchus	Thoracic Vert	Whole	1-9	0.99			Cortical		Brown	2
24	404	3	5	IIa	1	1, Lv-3	1	Mammalia	Large	O. hemionus	Metatarsal	Frag.	30-39	11.41	Distal	Adult	Cortical	Irregular	Brown	2

Appendix D Complete Stable Isotope Results

HP	Bag #	Taxa	Element	Floor	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
54	384	*Canis lupus*	*Ulna*	IIa	-20.01	3.08
54	319	*Canis lupus*	*Humerus*	IIc	-19.87	3.91
54	1361	*Canis lupus*	*Ulna*	IIc	-20.45	3.81
54	555	*Canis lupus*	*Tibia*	IIf	-20.78	4.21
54	1400	*Canis lupus*	*Metatarsal*	IIj	-20.78	3.29
20	323	*Canis lupus*	*Tibia*	IId	-20.14	4.18

HP	Bag #	Taxa	Element		$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
54	289	*C. familiaris*	Metacarpal	IIb	-15.47	13.76
54	343	*C. familiaris*	Fibula	IIe	-15.39	14.51
54	557	*C. familiaris*	Cervical vertebra	IIh	-15.88	13.53
54	557	*C. familiaris*	Axis	IIh	-15.86	13.47
54	494	*C. familiaris*	Thoracic vertebra	IIh	-15.91	13.75
20	489	*C. familiaris*	Metatarsal	IIj	-15.47	14.14
24	632	*C. familiaris*	Calcaneous	II	-15.00	14.78
24	443	*C. familiaris*	Calcaneous	II	-14.75	14.95
11	332	*C. familiaris*	Caudal Vertebra	IIa	-15.16	14.23

HP	Bag#	Taxa	Element	Floor	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
11	104	O. hemionus	Lumbar Vert	IIb	-19.78	3.67

HP	Bag#	Taxa	Element	Floor	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
20	490	Oncorhynchus	Thoracic Vert	IId	-16.57	9.61
20	328	O. hemionus	Lumbar Vert	IId	-20.43	4.17

HP	Bag#	Taxa	Element	Floor	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
24	404	O. hemionus	Metatarsal	IIa	-20.07	4.04

HP	Bag#	Taxa	Element	Floor	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
54	800	O. hemionus	Femur	IIa	-21.46	2.04
54	145	O. hemionus	Tibia	IIa	-21.74	3.61
54	805	O. hemionus	Radius	IIb	-21.22	3.09
54	1061	O. hemionus	Tibia	IIb	-20.61	4.02
54	1183	O. hemionus	Trapezoid Magnus	IIc	-20.4	3.52
54	1370	O. hemionus	Metatarsal	IIc	-20.82	5.88
54	49	O. hemionus	Pubis	IId	-19.42	4.8
54	888	O. hemionus	Ulna	IIe	-20.58	2.6
54	44	O. hemionus	Thorasic Vert	IIe	-20.52	3.59
54	394	O. hemionus	Phalange	IIf	-20.56	3.03
54	1342	O. hemionus	Tibia	IIg	-20.73	4.07
54	871	O. hemionus	Lumbar Vert	IIh	-19.3	4.14
54	878	O. hemionus	Astragalus	IIi	-20.28	3.03
54	1335	O. hemionus	Pubis	IIj	-20.51	3.99
54	1336	O. hemionus	Lumbar Vert	IIj	-20.5	4.12

HP	Bag#	Taxa	Element	Floor	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
54	1193	O. canadensis	Tarsal	IIc	-20.28	4.14
54	865	O. canadensis	Verterbra	IIh	-19.24	5.77

HP	Bag#	Taxa	Element	Floor	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
54	553	C. canadensis	Caudal Vert	IIf	-20.71	5.33
54	840	C. canadensis	Vertebra	IIh	-20.92	3.52

HP	Bag#	Taxa	Element	Floor	$\delta^{13}C$ ‰	$\delta^{15}N$ ‰
54	424	O. nerka	Thoracic Vert	IIa	-16.27	9.69
54	1373	O. nerka	Thoracic Vert	IIc	-16.14	9.7
54	1447	O. nerka	Throacic Vert	IIc	-16.7	11
54	1250	O. nerka	Pre-caudal Vert	IIc	-17.03	9.66
54	110	O. nerka	Throacic Vert	IIg	-16.06	9.99
54	1203	O. nerka	Throacic Vert	IIi	-14.68	13.22
54	1405	O. nerka	Throcsic Vert	IIj	-15.66	11.08

Appendix E $\delta^{13}C$‰ and $\delta^{15}N$‰ tables showing values for taxa per stratgraphic floor in HP 54, multiple samples for a single taxa and floor were averaged and are highlighted.

$\delta^{15}N$ ‰						
Floor Strat	**O.hemionus**	**C. familiaris**	**C. lupus**	**O. canadensis**	**O. nerka**	**C. canadensis**
IIa	2.83		3.08		9.69	
IIb	3.56	13.76				
IIc	4.70		3.86	4.14	10.12	
IId	4.80					
IIe	3.40	14.51				
IIf	3.03		4.21			5.33
IIg	4.07				9.99	
IIh	4.14	13.58		5.77		3.52
IIi	3.03				13.22	
IIj	4.05		3.29			
$\delta^{13}C$ ‰						
Floor Strat	**O.hemionus**	**C. familiaris**	**C. lupus**	**O. canadensis**	**O. nerka**	**C. canadensis**
IIa	-21.60		-20.01		-16.27	
IIb	-20.92	-15.47				
IIc	-20.61		-20.16	-20.28	-16.62	
IId	-19.42					
IIe	-20.55	-15.39				
IIf	-20.56		-20.78			-20.71
IIg	-20.73				-16.06	
IIh	-19.30	-15.88		-19.24		-20.92
IIi	-20.28				-14.68	
IIj	-20.51		-20.78			